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Retrenchment and Education.

WHETHER in the present financial circumstances of the country, the Department of Education should have been brought under the general operation of the retrenchment policy of the Government of India, is a subject on which there is bound to be an honest difference of opinion. We can very well understand the force of the argument of those who advocate retrenchment, that Education is a branch of administrative service and therefore must share its fortunes along with the other departments. Moreover it will be pointed out that in other countries affected by similar financial blight, the curtailment of educational grants has been accepted as inevitable in the process of readjusting the attenuated revenues to the demands of the several departments of administration. We are afraid that both the argument and the analogy are specious and indefensible. When we say this, we are not to be misunderstood as lacking in sympathy for the Imperial Government in the difficult situation with which they are confronted. Far from assuming a merely negative critical attitude, we are disposed to examine this somewhat difficult problem with a view to discover possible remedies.

At the annual budget session of the legislative bodies, it has become almost customary for the people's representatives to criticise the inadequacy of provision for Education and to direct the whole fire of the debate against the excessive expenditure on military and excise departments. The defence of the Government is well known. Now this chronic difference of opinion on the budget estimates between the leaders of the public and the administrators is due to a want of a clearly defined concept of the fundamental needs of the people whom they propose to serve. We quite see the necessity of spending even large sums of money on services designed for the maintenance of peace and order among the people and on others whose object is to earn more revenue for the State. But if peace, order and a prosperous finance are good, they must be good for something still nobler. At

best they are only a means for the attainment of those ideals which higher education visualizes, *viz.*, to mobilize the intellectual and material resources of the State for the common service of the people. When suggestions are made for the retrenchment of expenditure in certain departments of doubtful utility, the Government point out the impossibility of accepting such recommendations without seriously sacrificing administrative efficiency. It is not realized, however, that the efficiency of the administrator in particular and of the people in general must be the direct outcome of the training and outlook imparted to them in the Universities and the Colleges. Starve the latter, the former will automatically deteriorate.

The fundamental weakness of the whole educational organization in India is due to the fact that the movement took its origin in the seat of the Government and not in the heart of the people. It must necessarily follow that the progress of education and the development of the country must proceed leisurely, since common ideals of education do not inspire the Government and the people to direct their energies into a co-operative effort to utilize learning for the promotion of the happiness and prosperity of the country.

As in the affairs and concerns of individuals, so in those of Government, the practice of economy during periods of affluence will obviate the need for retrenchment in times of stringency. Economy is only expenditure with insight and courage and the greater part of such expenditure must be in the nature of productive investment. We are convinced that increased expenditure on education both by the people and by the Government is the surest and safest form of investment of private and public funds. The importance of such co-operation in support of higher education in India, as a result of a wider and more practical recognition of the common interests of the people with those of the Government, cannot be over-emphasized. Government responsibility in the matter was clearly accepted by Lord Curzon while addressing the Educational Conference in Simla so long ago in 1901. His Lordship declared, "I hold the education of the Indian people to be as much a duty of the Central Government as the police of our cities, or the taxation of our citizens. Indeed more so, for whereas those duties can be safely delegated to subordinate hands, the Government can never abrogate its personal responsibility for the living welfare of the multitudes that have been committed to its care." This is a public declaration by the the head of the Government, advocating the view we hold that the needs of education are far more imperative than the claims of any other department and thus implying that education should be properly provided for even if the public revenues have fallen. To argue that the Department of Education spends more than it contributes is obviously futile; to cut down grants to the Universities and Research Departments on account of shrinkage of finances cannot be regarded as an act of statesmanship, in any country especially in an educationally backward country like India.

It seems to us that without a policy of continuous and increased support to higher education and to Research departments both by the Government and by the wealthy section of the Indian public, India must inevitably lag behind. The landed aristocracy, the captains of industries, the merchant princes and other wealthy magnates should appreciate the close relationship of science, industry and human life and encourage scientific research, the results of which besides constituting a striking tribute to their acts of philanthropy, will also be available for utilization in the special branches of the activities in which they are interested. The main reason why science has not received so far its due support either from the Government or from the munificent public is that neither have fully recognized the fact that the expansion of higher education and the active promotion of research directly contribute to general efficiency and the earning capacity of the people. The economic independence of this country depends upon the impetus given to scientific research in the Universities. That the spirit of science is service should no longer be permitted to remain an article of mere

academic faith, but should be incorporated as the basic factor of the administration of the country and of the munificent activities of the public.

We conceive that the best results could be obtained in probably the shortest time, if the Government and the leaders of the public would jointly prepare a ten-year Educational Plan based on a well-considered programme of University teaching and research work. The financial contribution for this work should be derived from Government grants and people's donations and endowments calculated on the basis of the interests and resources of the contributors. The administration of the funds and the direction and control of research departments and of the expansion of University Education on special lines, ought to be entrusted to a Board on which all the interests are duly represented. At the end of ten years the whole work may be reviewed and a further programme of work arranged. We can indicate here only the broad outlines of the principles which ought to be the foundation of a new policy in accordance with which the expenditure on higher education and research will be repaid many times over by the creation of an enlightened, efficient and prosperous nation than which nothing better can be desired.

The Study of Nutrition in India.

By Col. R. McCarrison, C.I.E., K.H.P., M.D., D.Sc., LL.D., F.R.C.P., I.M.S., *Director, Nutrition Research Laboratories, Coonoor.*

ALTHOUGH the theoretical problems involved in the study of the Science of Nutrition are the same in all countries, the practical problems connected with it are widely different. It is in the latter regard that India presents so many difficulties, both economic and social. Nevertheless, there is no country in the world which affords ampler opportunities for this study—the very diversity of the races comprising its vast population, the contrasts in their physique and the differences in their food-habits and customs provide unrivalled material for the investigation of nutritional problems in the mass. The student of Nutrition has thus a vast field for investigation before him; but, unfortunately, the labourers therein are few, although the harvest it has to yield is rich. Early in his career the investigator will realize how closely the problems of Nutrition are interwoven with questions of custom and of caste, of habit and of prejudice, of poverty and of riches, of eugenics and of social reform. But these questions, whose solution would aid so greatly in the solving of the problems that are his immediate concern, are outside his domain; their solution is in the hands of others—the People of India themselves. He cannot, however, lose sight of the economic aspect of his work which must be of service to the poor as well as to the rich. It is not enough that he shall determine the food-requirements of individuals living under the varied climatic conditions of the Peninsula; he must determine for each race and for each caste not only the best but also the most economical means of satisfying them; for India is a land in which the poor far exceed the rich in numbers. Even when he has done this there will remain millions to whom the wisdom he purveys is useless, whose poverty is such that hunger and its satisfaction are their prime concern, and for whom the ways and means to better nutrition, and to the better health that it so surely brings, are unattainable.

It is not the purpose of this brief article to refer to the results already achieved in the Study of Nutrition in this country, but to indicate what, in the light of past experience, is needful for its proper continuance, prosecution and extension.

It will be obvious that the first step towards the solution of the problem of Nutrition in India is to survey the food-resources of the country and to classify its natural products into categories of nutritive value. This would involve the chemical analyses of many hundreds of food-materials; analyses which would include not only the better known constituents of food but those, such as certain of the rarer mineral elements, whose presence even in minute amounts may make all the difference between health and ill-health. It would involve also the

biological assay of hundreds of food-materials both from the point of view of the several vitamins and of other food essentials. Clearly this task is a gigantic one, requiring for its completion the employment of many chemists for several years to come. But it is a task that must be faced if India is to have any accurate knowledge of the physiological value of her own food-materials. Fortunately, there are many chemists in this country who, if afforded adequate facilities for their work, are competent to undertake the chemical assay of food; and who, with sufficient preliminary training, could undertake also the biological assay of food-materials. The difficulty is to find the money wherewith to employ them and the institutes in which to accommodate them. It is here that men of wealth, who desire their country's good, can find scope for their philanthropy.

The task, so briefly outlined above, is not one that should or could be undertaken by one Institution for the whole of India. As well ask a single Institute—say, in Paris—to cater for the whole of Europe, as one—say, in Coonoor—to cater for the whole of India. Each Presidency and Province has its own particular problems of Nutrition, its own particular food-materials, its own agricultural problems and its own economic questions; each should, therefore, have its own Institute for the study of Nutrition.

The next step in the proper study of this subject is to determine what are the natural products of each Province that can best, and most cheaply, satisfy the food-requirements of the people of that Province and to group these products according to their cost. It is idle to tell a poor man that a certain food-material is essential to his well-being when he has not the means to procure it. What the Institute has to do is to find some substitute for it which, even if not so good, is as good as the man can afford. A main concern of such an Institute would be the search for cheap and easily produced foods that are of high physiological value.

The third step is the drawing up of "bills-of-fare" suited to each class of the community and to every pocket. Amongst these some, designed for persons in the lower scale of social conditions, cannot be perfect, but they will be the nearest approach to perfection attainable under existing social conditions. An important function of any properly organized Institute for Nutrition should be propaganda.

The conclusion has thus been reached—and, it is hoped, on adequate grounds—that each Presidency and Province in India should have its own Institute for the study of Nutrition. To be most efficient it should work in close association with other departments of the State: the Agricultural (including Animal Husbandry), the Medical, the Veterinary, and the Public Health Departments. Its concern with the first has relation to the greater production of cheap foods of proven physiological efficiency, such, for instance, as the best kind of groundnut to grow; the determination of the food value of new strains of cereal grains—such, for example, as rice—evolved by the Department of Agriculture; and to the investigation of the connection between such influences as soil, irrigation, rainfall, external temperature and manures, on the nutritive value of the natural products of the Province. Its concern with the other Departments mentioned has relation to the effect of faulty nutrition in causing disease and in influencing its spread both in man and in his domestic animals. To this end dietetic and epidemiological surveys should be conducted in association with these Departments.

Finally, the Institute must have an educational function. It should provide courses of instruction for Medical men and women. Such courses should be compulsory for all medical employees of the Government.

How should an Institute, that is properly to fulfil all these functions, be organized? It should consist of the following twelve sections, each capable of expansion to any required degree—(1) Digestion and assimilation of food; (2) Metabolism and biochemistry; (3) Experimental medicine; (4) Pathology and Cytology; (5) Physics, bio-electric measurements, X-ray investigations, etc.; (6) Tissue-culture; (7) Chemistry of Food; (8) Biological assay of Food;

(9) Food-preservation, adulterants, etc.; (10) Epidemiological and Statistical; (11) Educational; and (12) Administrative. Anything less than this is inadequate and wasteful. An illustration will suffice to make this evident. No single investigator can in his own person be a finished experimenter, a pathologist, a cytologist, a bio-chemist, a physicist, a tissue-culturist, an epidemiologist and a statistician ; yet if problems of Nutrition are to be efficiently investigated they must be considered from the points of view of each of these experts. The animal experimented upon has some claim on the consideration of the experimenter and that claim is not morally or scientifically discharged so long as every fact—clinical, pathological, bio-chemical, bio-physical, etc.,—that its body has to reveal, is not ascertained and recorded. The failure to record every such fact is frequent and this failure is wasteful as well as unscientific. An imperfectly organized Institute is, therefore, a crippled and inadequate instrument of research, however competent the individual members of its staff may be. The work of the Experimental Pathologist, for example, must ultimately come under the scrutiny of the Bio-chemist or the Bio-physicist and that of them all under the scrutiny of the Statistician. This is best done at one and the same time and not piece-meal and following vain repetitions.

It may be asked why an organization, seemingly so elaborate, is needed for the study of the relatively new Science of Nutrition. The answer is that the efficient study of Nutrition is the very foundation of Medical Science. Medicine is still enamoured of the "specific causes" of diseases and, perhaps, too little mindful of the factors—often more controllable than the specific causes themselves—that admit of the operation of these causes. Of these factors faulty nutrition is one of the chief; and in the study of the Science of Nutrition lies the greatest hope for the future of Medicine.

We understand that the Council of the Indian Institute of Science, Bangalore, at their meeting held on 18-7-1932 have elected Sir C. V. Raman, Kt., M.A., D.Sc., LL.D., F.R.S., N.L., as Director. He is to succeed Dr. M. O. Forster, D.Sc., F.R.S., in April, 1933.

The Developmental History of the Primates.

THE subject of the Croonian Lecture by Professor J.P. Hill,* is a classic memoir expounding the developmental features of the Primates. Our knowledge of the classification of this order of mammals has, within recent years, undergone great vicissitudes. In his lectures delivered at Princeton University, Hubrecht propounded the amazing view that Tarsius is not a lemur and that its position, "lies somewhere between an unknown type of insectivore and our modern monkeys and man", and accordingly suggested the restriction of the name of Primates to the inclusion of Tarsius and Simiæ, the lemurs being thus excluded. Hæckel in the subsequent year put forward the theory that the Primates form a natural monophyletic group descended from a common ancestral stock which he designated Lemuravida and he recognized five stages in the evolution of man, *viz.*, Prosimiæ, Simiæ descended from the latter and including the Platyrrhinæ and Catarrhinæ, the Catarrhine Cercopithecidæ, the Catarrhine Anthropoidæ and finally Pithecanthropi leading to man. In systematic zoology, the classification based on Max Weber's "Die Saugethiere" which recognizes a tripartite division of the order into Lemuroidea, Tarsioidea and Anthropoidea, is generally followed. As the outcome of his studies on the Primate Brain and on embryological grounds, Elliot Smith and Hill supported this view. Now as the result of his extensive investigations on the developmental features of the several sub-divisions of the order, Hill recognizes four clearly defined developmental stages which he calls the Lemuroid, the Tarsioid, the Pithecoid and the Anthropoid. The comprehensive evidence which he adduces in the body of the Lecture in support of these developmental stages, leads him to recognize that they practically represent the phyletic stages in the evolution of the Primates. Hitherto systematic zoologists for the purposes of a scientific classification relied on the morphological features of

* J. P. Hill—Croonian Lecture—Phil. Trans., Series B, **221**, 45, 1932.

the embryos and the view of Hubrecht that the leading features of the segmentation and the blastocyst have a taxonomic value, is, after a wider review of the development of placentation by Hill, established as a fundamental point in the scheme of classification within the group of Primates. He recognizes four types of placenta, the generalized or Lemuroid, the transitional or the Tarsioid, the annectant or Pithecoid and the terminal or Anthropoid. The Lemuroid placenta is diffuse, non-deciduate, epithelio-chorial in type and represents a primitive or generalized form, being the inheritance from the non-deciduate ancestors of the primitive stock and there is not much evidence for considering it as a secondarily simplified placenta derived from the deciduate hæmochorial type. The Tarsioid placenta combines characteristics peculiar to Lemuriformes and others, partly anticipatory of the Pithecoid and partly specialized and peculiar to itself. This is precisely a combination of features in the developmental history of Primates which would represent as the transitional stage between the Lemurs and the Pithecii, the gap between which would not otherwise be bridged. The Tarsioids are therefore regarded as taking origin from the basal Lemuroid stock and giving origin to the Pithecoid grade. The fundamental agreements of the placental history of the Platyrrhine and Catarrhine monkeys lead Hill to discard the theory of the diphyletic origin of these two groups from Lorisiform and Lemuriform ancestors, and to postulate a common ancestral stock from which they have evolved along two divergent lines of descent. The Platyrrhines would seem to be the direct derivatives occupying a somewhat lower developmental plane; but the Catarrhines represent the more progressive branch and as a result of modifications of their placental features, some one or other member of this group gave origin to the Anthropoid grade in the Primate evolution which includes Apes and Man. Whether morphological, palæontological and other evidences would lend support to the complex and large question of the phylogeny of the Primates as sketched by Hill on consideration of the placenta of the several sub-divisions, would be the most fascinating and fruitful field of study. At present the balance of evidence lends a fair measure of support to the monophyletic view which Hill has adopted in his paper.

Letters to the Editor.

[*The Board of Editors do not hold themselves responsible for opinions expressed by correspondents. No notice is taken of anonymous communications.*]

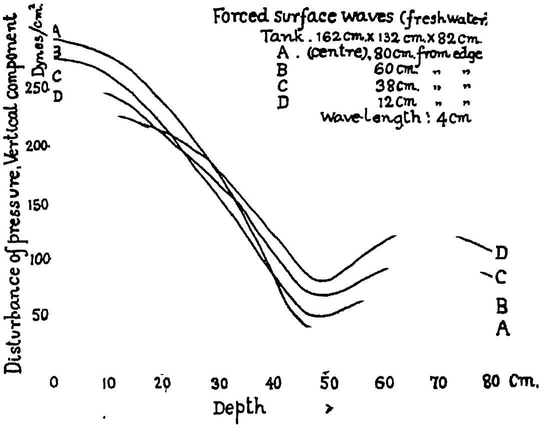
Disturbance of Pressure at the Bed of a Deep Sea.

THE determination of the disturbance of pressure at the bed of a deep sea is of fundamental importance in the theory of microseisms. The ordinary hydrodynamical theory of *irrotational* gravity waves on the surface of a *perfect* fluid indicates that there is no pressure disturbance at the bed of a deep sea. But the sea-water is viscous and the sea-waves are generally rotational; the theory is therefore inapplicable. When the "eddy-viscosity" and the rotational character of the sea-waves are taken into consideration, it is found that the motion is mostly confined to a superficial layer. For the conduction of pressure disturbance, this layer behaves almost in the same way as a shallow sea, and a definite disturbance of pressure therefore exists at the bottom of the deep sea.*

Direct experimental verification of the disturbance of pressure at the bottom of a deep sea is, of course, out of the question, but we can imitate the conditions in a large experimental tank and take measurements. The essential requirement is that the surface waves should have very small wave-length compared with the depth. We therefore took a strong galvanized iron tank of dimensions 162 cm. × 132 cm. × 82 cm., filled it to a depth of 80 cm., and mounted it over loose packings so that the vibrations of the ground due to the movements of the observer and other causes might not be communicated into the water in the tank. Waves of any wave-length from 2.5 cm. to 10 cm. were generated by an electrically maintained

*Banerji, Phil. Trans. Roy. Soc., 229A, 287, 1930.

vibrator of variable periods and also by making a current of air impinge over a small area of the water surface at *various* angles. The vertical component of the disturbance of pressure was measured by sinking rigidly supported tubes of large diameters (2 cm. to 10 cm.), open at both ends, vertically downwards to various depths and recording the oscillations of a superposed oil column or of a float inside the tubes by optical methods. The pilot tube and micro-manometer proved too insensitive for these measurements.



The variation of the mean disturbance of pressure with depth based on a large series of observations has been shown in the figure. The vibrator (or the blower) was allowed to work near the mid-point of one transverse edge of the tank and measurements of the amplitudes of the pressure oscillations were taken at 80 cm. (centre), 60 cm., 38 cm. and 12 cm. from the mid-point of the opposite edge. The curves show that owing to increasing distance from the vibrator, the disturbance of pressure at the surface undergoes a decrease as we move from the centre to the edge. But at the bottom, the relationship is reversed; it is maximum near the edge and decreases to minimum at the centre. The form of the curves is very nearly the same for any wave-length between 2.5 cm. to 10 cm. The observations were repeated in a reinforced concrete tank of dimensions, 190 cm. × 190 cm. × 95 cm. built on rocky soil and identical results were obtained.

The method does not permit the measurement of the disturbance of pressure exactly at the bottom. The curves were therefore drawn so as to reach the bottom with continuous curvature through the large number of observational points obtained at small distances apart very close to the bottom. The disturbance of pressure at the bottom is probably somewhat larger than that given by the curves because the boundary effect when the measuring tube is close to the bed will make it record a lower value. The experiments confirm the view advanced in the paper referred to above that there is a definite disturbance of pressure at the bed of the deep sea. Further observations with forced waves of various types on fresh as well as sea-water are in progress and a full account will be published in due course.

S. K. BANERJI.
S. S. JOSHI.

The Observatory, Bombay,
May 13, 1932.

Autonomous Movement in the Leaves of 'Curculigo Recurvata', Dryand.

DURING the summer of 1930, the writer, with a party of students, passed through Sikkim on his way to Central Tibet. Between Darjeeling and Gangtok, the capital of Sikkim, *Curculigo recurvata* was seen growing abundantly along the roadside in many places. It was the beginning of July and the air was very warm and humid and usually quite still. This was particularly the case on many days in the morning. It was noticed on such days, that is, when the air was very humid and there was absolutely no breeze, that in some plants of this species a leaf would begin to perform to and fro movements all of a sudden, go on for about half a minute or so and then stop by itself. All the other leaves of the plant would be absolutely still and no leaves of any other plants in the neighbourhood would show any movements. One can almost use the word deliberate to describe the movement. It was very regular and the distance travelled each way, right and left, was about the same. Sometimes it so happened that when one leaf had finished the movement another

leaf of the same plant would take it up a little later. It was also found that sometimes the movements could be started in a leaf, even in one which had just stopped moving, by striking its base with a stone thrown at it or by stroking it by means of a stick. The rate of the movement varied a good deal, being between 40 to 120 complete oscillations per minute. It is especially to be noted that the movement took place when the weather was very warm and the air was absolutely motionless and very moist. As these plants generally grow where the vegetation is very dense and often under larger shrubs and trees, they are, therefore, particularly affected by the closeness and the moisture of the air. It almost seems as if the plant is fanning itself. Unfortunately the mechanism of the movements could not be investigated though apparently it has something to do with the changes in the turgor of the cells at the base of the leaf. The movement was also cinematographed and the picture was shown at the Session of the Indian Science Congress at Bangalore last January. Since such a movement in this plant has never been described so far as the writer is aware, it is thought desirable to put it on record. It may be also mentioned that this plant is fairly commonly cultivated at various places. I have seen some plants growing in the Residency Garden at Gangtok. These also showed the movement though not so actively as the wild plants, but even here the movement was seen only in the morning. I understand that the plants are fairly common in the gardens of Calcutta but no movement has been observed in them. The writer has tried putting a plant in a very shady and moist place in Lahore and even tried stroking the leaf-base many times during the last two months but no movement has ever been seen. S. R. KASHYAP.

Lahore,
June 20, 1932.

The pH of Organs in Normal and Pathological Conditions.

IN the absence of any reliable method of determining the pH of different parts of the body in the living subject, the glass electrode, when employed as soon after death as possible, is the most reliable means available for such determinations. It has been observed, by G. Sankaran in McCarrison's Laboratory at Coonoor, that the pH of animal tissues does not change within two hours after death, the temperature of this Laboratory being 21°C. But it is advisable to keep the tissues or body fluids in cold storage (2°C to 4°C) if readings have to be made some 4 to 5 hours after death otherwise a change to the acid side is likely to occur. Contrary to the general belief that the pH of body fluids is round about that of blood-plasma (7.4 to 7.6) it has been found that organs may have a pH ranging between 5.84 and 7.93. Each organ appears to have its own normal range of pH. The heart, kidney and liver show a high acidity due perhaps to great activity of their cells.

At present the normal pH values of the various organs of the body have been worked out for pigeons and rabbits ; those for other animals are now in process of determination.

The effect of pathological changes on pH has so far been studied in connection with experimentally-produced Goitre and Beriberi. Hyperplastic goitres produced in rabbits by an exclusive diet of raw cabbage show a significant change of pH to the alkaline side as compared with normal glands. In experimentally-produced *Beriberi Columbaram*, with marked hypertrophy or dilatation of the heart, there is a significant increase in acidity of the ventricle as compared with the auricle which remains normal. In pigeons suffering from experimentally-produced *polyneuritis*, with retraction of the head and neck, the different parts of the brain were found to be markedly acid while nerves like the vagus and sciatic remained normal. R. McCARRISON.

Nutrition Research Laboratories,
Coonoor,
June 28, 1932.

Mineral Metabolism and 'Stone'.

IN the early stages of the experimental production of urinary calculus in McCarrison's Laboratory at Coonoor, deficiency

of vitamin-A was found to be the chief factor concerned in the causation of this condition. The 'stones' so produced consisted for the most part of magnesium-ammonium phosphate. Later, in an attempt to alter the composition of these stones by purely dietetic means, calcium was added to the diets deficient in vitamin-A. The stones resulting therefrom were composed either of calcium carbonate or calcium hydroxide. Metabolic studies, made by S. Ranganathan, in rats fed on such diets showed a great excretion of calcium through the urinary tract. With a view to diverting the course of the urinary calcium, phosphate was added to the lime-rich-vitamin-A-deficient diets. Not only was the urinary calcium reduced but there was also a marked lowering in the incidence of stone, in spite of the fact that the diets were still deficient in vitamin-A. Such a result was to be expected as the phosphate was able to remove one of the chief pre-disposing causes of stone-production, *viz.*, excess of calcium in the urine. Recently, Dr. Watchorn produced stones experimentally by means of magnesium-rich diets. The calcium-content of the stones resulting therefrom was almost identical with those produced in the Coonoor Laboratory on calcium-rich diets. But the stone-formation brought about by magnesium-rich diets is stated, by this observer, to be preventable by the addition of lime. This function of calcium, if corroborated, will form an interesting study as it would be an instance of the neutralization by one basic radical (Ca) of the stone-producing potency of another (Mg.).

R. McCARRISON.
Nutrition Research Laboratories,
June 28, 1932.

Raman Effect in Liquid Carbon Dioxide.

THE Raman Effect in carbon dioxide gas has been studied by Dickinson, Dillon and Rasetti,* and recently by the author,† but there exist no data regarding this substance in the liquid state. A comparison of the Raman frequencies for various molecules in the liquid and gaseous states is of great importance and certain very interesting results have already been obtained. Amongst various other polar molecules the case of hydrogen halides studied in detail by Salant and Sandow‡ is notable as the sharp lines obtained in gases are replaced by broad bands in the liquids, the frequency shifts in the former being sensibly higher than in the latter. Non-polar molecules, however, stand on a different footing, and the case of carbon dioxide affords a beautiful example of the same. The results obtained by the author for the liquid at room temperature are compared below with the known frequencies of the gas :—

CO_2	Liquid	1281	1386	1412
	Gas	1285	1388	1408

The frequencies hardly undergo any change as we pass from the liquid to the gas and it may also be noted that in addition, the lines are equally sharp in both cases.

S. BHAGAVANTAM.
210, Bowbazaar Street,
Calcutta,
June 28, 1932.

* Phys. Rev., **34**, 583, 1929.
† Ind. Jour. Phys., **6**, 319, 1931.
‡ Phys. Rev., **37**, 373, 1931.

Detection of Enzymes by "Spot Tests".

THE detection and characterization of enzymes in biological fluids offer considerable difficulties when they are coloured and are available in micro-quantities.

A drop of the substrate followed by a drop of the fluids is mixed on a strip of fat-free filter paper which is afterwards kept under a bell-jar over water for about 30 minutes. Necessary controls are run side by side. The spot is examined by suitable reagents. In some cases, as for example, oxidases and peroxidases, a visible change is immediately observed. With esterases and urease the change in hydrogen-ion concentration is observed by appropriate indicators. Where a reducing sugar is released on hydrolysis, as in the case of the common carbohydrases and glucosidases, Fehling's test is employed, a jet of steam being directed on to the spot to facilitate the reduction. A brick red

or orange colour indicates the presence of the enzyme.

This method which is rapid and yet simple, has been successfully employed for a determination of the enzyme make-up of plant saps and insect body fluids.

M. SREENIVASAYA.
B. N. SASTRI.

Indian Institute of Science,
Department of Bio-chemistry,
Bangalore,
June 27, 1932.

Hyperfine Structure and Isotopes.

IN a number of cases hyperfine structure of spectral lines has been successfully explained by ascribing a spin moment to the nucleus. An examination of the lines, under suitable conditions with a low density, long column discharge, often reveals in addition to satellites that answer theoretical expectation, others which are comparatively faint. One has to take the utmost care to avoid mistaking spurious lines (ghosts) for actual satellites. Especially is this necessary when the satellites are faint compared with the known strong ones. In photographing the structure of a line an exposure enough for the strong satellites would not be adequate to bring out the fainter ones, and an exposure that is necessary to bring out the faint satellites would result in the strong satellites being over-exposed, the faint satellites then being lost in the dark background. A number of lines, especially those of Cd. I, have been examined in the Central College Physics Laboratory, with a long column discharge as source, a stream of cadmium vapour being sent through a mercury arc with tungsten anode and cooled mercury cathode, three Lummer plates made by Hilger, two of quartz and one of glass, being used as the analysing instruments. A careful examination has revealed the existence of satellites over and above those that can be accounted for on the hypothesis of a nuclear moment of $\frac{1}{2}h/2\pi$. For instance, in the case of the line 5086 ($5\,^3P_2 - 6\,^3S_1$) the following is the structure according to the present writer:

(*a*) +0.076 (2)
(*b*) +0.039 ($\frac{1}{2}$) (*new*)
(*c*) +0.011 (1 ?) (*not recorded by others*)
0.000 (10)
(*d*) −0.026 (4)

The satellites (*a*), (*c*) and (*d*) are the theoretically expected ones. The unaccounted satellite (*b*) in some plates is seen as a close double with a separation of 0.012 Å. This satellite has also been measured directly with a micrometer eye-piece.

The existence of these faint satellites suggests the possible presence of other isotopes, in relatively very small quantities as in the case of hydrogen and oxygen. The nuclear moment in the case of these isotopes may be different from that of the more abundant ones. In view of this possibility it appears to the author that a careful study of hyperfine structure with special reference to faint components is important.

B. VENKATESACHAR.

Physics Department,
Central College,
Bangalore.
July 25, 1932.

The Occipital Condyles and the Urostyle of the Engystomatidæ.

THE development of the Vertebral Column in Anura has been engaging our attention for some years and in the meantime, Dr. Mookerjee has published a paper on this very subject.* We have noticed in our preparations of the larvæ of *Microhyla*, *Cacopus* and *Kaloula* interesting features about the occipital zone and the urostyle, photomicrographs of which are reproduced here. Dr. Mookerjee also draws attention to the same characteristics in the case of *Rana* and *Bufo*. It is not quite certain whether the development of the vertebral body and neural arch in the *Engystomatidæ* is in conformity with what has been described by Dr. Mookerjee in *Rana*, *Bufo*, *Xenopus* and *Bombinator*, and we hope to be able to give a fuller and more detailed account of the

* Phil. Trans. Roy. Soc., Vol. 219, Series B, No. 465, 1931.

formation of the vertebral axis in the Indian *Engystomatidæ* at an early date. It is a well-known fact that the *Engystomatidæ* are an extremely specialized group, showing anatomical features which exhibit, in several particulars, a striking contrast with the usual more generalized anuran forms. It will not be surprising if the ontogenetic history of the members of *Engystomatidæ* should deviate from the normal type.

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L. S. RAMASWAMI.

University of Mysore,
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Bangalore,
July 5, 1932.

Fig. 1. Frontal section of the tadpole of Microhyla, size 21 mm., showing the development of the urostyle.

Fig. 2. Frontal section of the tadpole of Microhyla, size 21 mm., showing the development of the Occipital condyles and the Atlas.

Cystine Metabolism in Sheep.

RIMMINGTON and Bekker in a recent communication* reviewing the position of the problem of cystine metabolism of sheep, draw attention to the fact that up till now, neither sulphur nor any of its compounds has been found to be capable of replacing cystine in the diet, but that while laboratory animals have been shown to be incapable of synthesizing cystine, it was likely that sheep with their complex stomach and the rich bacterial flora in it, may be able to do so.

During the course of an investigation into the possible nutritional factors involved in the improvement of the quality of wool of indigenous breeds of sheep, it was observed that the feeding of native sulphur resulted in an increase in body weight, a heavier fleece and a higher cystine content of the wool. The wool of animals getting 0.07 to 0.1 gram sulphur per day had a sulphur content of 3 per cent while that of the control animals was 2.7 per cent. This increase in the sulphur content of the wool points to the fact that the sulphur had been metabolized, and the metabolite took part in the synthesis of cystine which appeared in the wool. A detailed study of this aspect of nutrition of sheep has been commenced. A complete sulphur balance-sheet will be worked out, when it is hoped further light can be thrown on the opposite mechanism of the cystine synthesis.

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Animal Nutrition Section,
Chemical Laboratories,
Agricultural Research Institute,
Coimbatore,
June 30, 1932.

* Nature, Vol. 129, No. 3262, 7th May 1932, pp. 687-8.

Sensitive Flame as Microphone.

STROBOSCOPIC examination of sensitive flames has shown that, under the influence of sound, certain flames assume a wave structure travelling upwards; the amplitude of these waves increases with height until the crests and troughs break away and travel apart from each other—finally resulting in turbulent motion a little higher up the flame. Frequency of these waves is, of course, that of the impinging sound. Two platinum electrodes made of No. 26 wire are placed in the flame one above the other about an inch or so apart in the plane of the waves in the flames. A small voltage is applied to these electrodes in series with a one megohm resistor, which is connected to the input of a high gain amplifier, the output being connected to an electro-dynamic speaker or to high impedance phones.

The system sets singing when the head phones or the speaker is in close proximity of the flame, just like the singing telephone. That this is due to the acoustic feed back from the output to the input is proved by keeping the phones or speaker at the same distance from the electrodes, removing the flame, and shorting the electrodes directly or through a high resistance; this stops the singing. It is not necessary, however, to close the circuit at the electrodes to stop the singing; it is done in order to simulate the electrical conducting path of the flames, so that there be no doubt as to the electro-acoustic behaviour of the sensitive flames.

When a continuous or speech note is made to impinge on the flame, a great deal of noise is produced in the speaker accompanied by a characteristic tone. There also seems to be a certain roaring frequency of the noise. Back of all this there is a faint suggestion of the input tone. Efforts are being made to minimize the noise, in order to bring out the required notes.

LAL C. VERMAN.
Department of Electrical Technology,
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Bangalore,
June 29, 1932.

On the Susceptibility of Liquid Mixtures with a New Apparatus.

IN continuation of our preliminary account submitted to the XIX Indian Science Congress, January 1932, on the diamagnetism of liquid mixtures by weighing pendant

drops, the deviation of the susceptibility of acetone-chloroform mixture from the mixture law has been further investigated with a new apparatus. A glass test-piece immersed in the liquid is suspended at the lower end of a torsion fibre in a non-homogeneous magnetic field. The angular twist due to the couple on the test-piece and the volume susceptibility of the liquid surrounding it being linearly related, the specific susceptibility has been determined with an error of about one per cent. in all cases. The results for the above mixture show a deviation of about 3 per cent. agreeing well with the results of Ranganadham*, Hans Buchner† and Farquharson‡. Ramachandra Rao and Sivaramakrishnan¶ however conclude that the mixture shows no deviation, though a deviation is to be expected in view of the fact that other physical properties like viscosity, vapour pressure|| and even magnetic rotations§ show a maximum deviation at about the same composition of the mixture. Since this composition corresponds to equi-molecular proportions of the constituent liquids, the existence of a new compound is rendered highly probable.

A paper giving details will be published elsewhere.

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July 5, 1932.

* Ind. Jour. Phys., VI, pp. 421-431, 1931.
† Nature, **128,** p. 301, 1931.
‡ Nature, **129,** p. 25, 1932.
¶ Ind. Jour. Phys., VI, pp. 509-526, 1932.
|| O. Faust, Zeit. Physick. Chem., **79,** p. 97, 1912.
§ Mathur and Kapur, Ind. Jour. Phys., VII, pp. 15-18, 1932.

On the Longevity of Micro-filariæ (Wuchereria) Bancrofti.

ANENT the theory of cyclical parturition of adult female Filariæ to explain the periodicity of the appearance of Micro-filariæ in peripheral blood and the support due to the evidence brought by O'Connor and others, the following observations of maintaining Micro-filariæ alive for varying periods in Auto-Sera by the same method as that adopted for tissue culture would be of interest. Midnight blood from an up-country girl aged 15 was taken on sterile cover-slips and inverted over vaselined hanging drop troughs of thick slides. These were examined immediately and later, from time to time, for the presence of live motile Micro-filariæ. They averaged between 2 and 3 per coverslip. After observation these coverslips were kept at 37° C. in an incubator. On the 3rd day a little sterile serum from the same patient was added to the former preparation. By this method these Micro-filariæ could be kept alive for a period ranging between 120-126 hours. After 72-96 hours the motility of these Micro-filariæ began to diminish and larger or smaller vacuoles began to appear in the Protoplasm, which at the same time began to assume, more or less, a ground-glass appearance. The same observations were repeated on another patient in whom the number of Micro-filariæ circulating in the peripheral blood was less numerous. It would appear from the above that the Micro-filariæ are not removed within 24 hours by death due to "old age".

C. V. NATARAJAN.
Public Health Institute,
Bangalore,
July 7, 1932.

Research Notes.

Interaction between Gamma-Radiation and Atomic Nucleus.

IN the June number of the Proceedings of the Royal Society (*Proc. Roy. Soc.*, **A. 136,** 662—691) Messrs. J. H. Gray and G. T. P. Tarrant give an account of their experiments on the effect of irradiating lead, tin, iron and water by γ-rays from Thorium C and also by the high frequency components of Radium C. They started by a careful study of the secondary radiations emitted by lead at angles of 125° and 145°. The absorption of the incident radiation is attended with the emission of two characteristic radiations of energies

0.47×10^6 and 0.96×10^6 electron volts respectively. In this interaction it is inferred that the extra-nuclear structure plays no part but that the incident quantum excites the nucleus, which subsequently emits the absorbed energy in the form of characteristic radiations. In order that such an excitation of the nucleus may take place, the energy of the incident quantum must be greater than about 2 million volts. They find that the intensity of the radiation which is emitted uniformally in all directions varies as the square of the atomic number. The fact that the components of the scattered radiation are found to be the same in each case has led the authors to suggest that the secondary radiation is characteristic of some common constituent of all nuclei, say, an α-particle. 'It may be,' says Lord Rutherford, in his opening address of the discussion on the Structure of Atomic Nuclei before the Royal Society, 'that the characteristic radiations observed may represent some of the modes of vibrations of the particles itself.'

Notes on Zygospore Formation in Spirogyra.

[Prof. R. R. Gates, *J. R. M. S.*, LII, Part I, 30-32.]

FORMATION of Double Zygospores in two species of Spirogyra provisionally determined as *S. fluviatalis* and *S. decimena* is described. The double Zygospore is formed in *S. fluviatalis* by two cells each conjugating as males with a very long cell of a female filament. This cell was presumably binucleate but the cross-wall formation has for some reasons been inhibited. The double Zygospore presumably contains two nuclei each diploid and on fusion before germination, a tetraploid nucleus would result which would give rise on germination, to a diploid instead of a haploid filament. *S. decimena* is peculiar for its Zygospores which germinate without the usual resting period. Another interesting peculiarity observed in this material is the formation of a heavy yellow wall round the contents of the two fusing protoplasts before their fusion is complete. Such incomplete zygospores were formed by the rapid secretion of the wall, probably as a result of the change in conditions when the material was removed from the pond and placed in a jar.

A Study in Brachiopod Evolution.

AN interesting example of what has been called 'explosive evolution' has recently been worked out by Dr. C. L. Fenton (*Publications of the Wagner Free Institute of Science*, Vol. II) as a result of his studies of two Devonian spirifers—*S. orestes Hall* and Whitfield *S. hungerfordi Hall*, which occur together in large numbers in the upper Devonian shales near Cerro Gordo County, Iowa. From an examination of more than ten thousand specimens collected zonally from these beds, Dr. Fenton has worked out a phylogeny for the Devonian spirifers according to his ideas of their supposed mode of evolution and concludes that the evolution was orthogenetic and had a physiological basis in racial senescence conditioned by a decreasing metabolic rate,—a conclusion rather startling to those who "look upon instances of great variability and of prodigality of individuals as evidence of rejuvenescence and vigour".

Contributions to our Knowledge of the Life in Vertebrate Animals—V. Mammals.

[Stanley S. Flower, *P.Z.S.*, 1931, Part I, pages 145-234. Previous contributions on Fishes, Batrachians, Reptiles and Birds published in *P.Z.S.*, 1925.]

IT is a summary of notes collected during the past 35 years. The point of interest is that the life-spans of domestic animals like the Cat, Dog and the Horse have not been increased or decreased by the untold thousands of years that they have been under human control. Their lives are of the same length as would be expected from that of their wild "unimproved" relations. The potential longevity of Mammals differs from that of birds, reptiles,

amphibians and fishes in that, in the large majority of species, there is an additional controlling factor—teeth. *Pari passu* with the enquiries concerning longevity, information about the gestation periods of Mammals has been collected ; there appears to be no relation of correlation between periods of gestation and either specific or potential duration of life.

The Existence of a Neutron.

DR. J. CHADWICK announced early this year (*Nature*, **129**, p. 312, Feb. 1932) that the radiation emitted when beryllium is bombarded by α-particles from polonium is of the nature of neutral particles of mass nearly equal to that of the proton. He pictures these 'neutrons' either as small dipoles or as protons embedded in electrons like hydrogen atoms in the zero quantum state. In a recent communication (*P. R. S.*, 136, pp. 692—708 and p. 747, 1932) he has adduced evidence showing that the mass of a neutron lies probably between 1.005 and 1.008. This conclusion has been reached by a study of the collisions of these particles with hydrogen and with nitrogen, and also from the energy equation of the transformation process of boron

$$B^{11}+He^{4} \rightarrow N^{14}+\text{Neutron}$$

Bothe and Becker's view, that the secondary radiation is of the gamma type, has been shown to be untenable, if the conservation of energy and momentum is to be maintained in these collisions. In a succeeding paper in the same number of the Proceedings, Dr. Feather gives support to the view of Dr. Chadwick from his observations of neutron collisions with nitrogen nuclei. In the next paper Mr. Dee describes experiments which indicate a low probability for neutron collisions with electrons resulting in the production of recoil electrons. Dr. Chadwick concludes with a picture of the atomic nuclei made of α-particles, neutrons and protons, with no place for electrons with spin or magnetic moment. More recently H. S. Allen (*Nature*, **129**, p. 830, 1932) however mentions that these corpuscles of unit mass may each be composed of a pair of neutrons with negligible magnetic moment, and that further search may reveal particles with half the mass and possessing a magnetic moment.

Sugarcane-Sorghum Hybrids.

THIS interesting inter-generic hybrid promises to be of economic value since sugarcane is vegetatively reproduced in agricultural practice so that any sterility in the flowers is of little importance. It is hoped that such hybrids will shorten the minimum length of the growing season for sugarcane. The hybrid was first reported in the *Agricultural Journal of India* for March 1930. In the February number of the *Indian Journal of Agricultural Science*, Rao Bahadur T. S. Venkataraman and R. Thomas describe the technique employed, the general characters of the new "canes" and a summary of the evidence that they are actually cane-sorghum hybrids. A further paper containing the results of cytological studies is promised.

The Effect of Ultra-Violet Radiation on Growth and Respiration of Pea Seeds.

[Mortimer P. Masure—*Botanical Gazette*, XCIII, 1.]

AFTER giving a detailed experimental account of the previous works on the subject and the statistical methods the author subjected seeds of *Pisum sativum* to a radiation of respiration of etiolated Pea-seedlings was also studied. Ultra-violet radiation of 3650 A. U. wave-length as employed by the author, in the absence of all other radiations throughout the experiment exerts a stimulative action on the subsequent rate of growth of the hypocotyl of Pea seeds irradiated in the air-dry condition. The rate of respiration of etiolated Pea-seedlings is temporarily increased by treatment with the above radiation, the effects in the two cases being incidental rather than cumulative.

Micronuclear Variations in Paramœcium Bursaria.

[Lorande Loss Woodruff, *Quart. Journ. Micros. Sci.*, **74**, (IV) 537-545, 1931.]

THIS work is based on a collection of Paramœcium bursaria made in July 1924 from a pond at Woodshole and a pedigree race of binucleate animals started in July 1924 and cultured till July 1931 has been studied. Marked variations occurred in the micronuclear number, ranging from four to the amicronucleate condition in genetically related animals. Endomixis or conjugation has never been observed in the amicronucleate animals which are capable of independent existence. This phenomenon supports the identification of the macronucleus and micronucleus as the segregation of somatic and generative elements into discrete bodies within the cell.

Mountain Building.

IN a recent number of the *American Journal of Science* (Fifth series, Vol. 23, No. 134) A. C. Swinnerton has edited an important paper on the study of mountain building, from the extensive unpublished notes which Prof. J. B. Woodworth left when he died in 1925, based on his extensive field work in the Rocky mountains and in the southern Appalachians. After considering the classical and generally accepted sequence of orogenic developments during the process of mountain building, the late Prof. Woodworth holds that an important place should now be given to an additional factor in this sequence, *viz.*, " a stage of tension in the crust which results in faults of the gravity type". Attention has also been drawn to the relation of igneous rocks to the contrasted compressional and tensional phases of mountain building, and evidences have been put forward to infer that the granite-rhyolite magma is the upper differentiate of a common initial magma forced up in the compression phase while the more fluid basaltic magma comes up later under the gravitational adjustment of broken and settling fault blocks.

Forecasting Frost.

GIVEN adequate notice, the grower of valuable crops and fruit trees can often do a good deal to minimise or avoid damage. In the plains of Northern India the relative rarity of severe frosts and the uncertainty as to when they will arrive coupled with the possibility of saving some crops at least by simple measures, add to the possible value of frost warnings. Barkat Ali and S. N. Naqvi, in a paper in the December number of the *Indian Journal of Agricultural Science*, on "The Correlation between frost and the preceding meteorological conditions", show that from observations of the wet bulb and dry bulb temperatures at 4 p.m. a fairly accurate local frost forecast can be made.

Modification of Mammalian Sexual Cycles : Reactions of Ferrets ('Putorius vulgaris') of both sexes to Electric Light added after Dark in November and December.

[Thomas Hume Bissonnette, *Proc. Roy. Soc.*, Series B, **110**, 767, 1932.]

THE author adduces evidences in favour of the view that "the sexual cycles are more or less conditioned by the daily light ration from the visible region of the spectrum". Among the ferrets experimented upon, it was noticed that the females were completely dependent on light ration than the males. In the birds, on the other hand, the males respond to light treatment more quickly and just as completely as females. The ovaries of the birds stimulated thus artificially by light develop large follicles.

Pre-Carboniferous 'Boulder Beds'.

THE paper on the pre-Carboniferous exotic boulders in the 'Caney shale' in the north-western front of the Ouachita mountains of Oklahoma by W. A. J. M. Van der Gracht (*Journal of Geology*, Vol. XXXIX, No. 8) is interesting since the author has, from a careful study not only of the exotic blocks themselves and their matrix but of the structure of the entire region, put forward some evidences to show that these

blocks and boulders are *not* of glacial origin, and at least in the case of the large blocks, not sedimentary. He believes that "they are tectonic blocks similar to such as we find in the frontal thrust sheets of many other mountain chains with a nape structure comparable in particular to the Flysch blocks of the frontal Alpine thrust sheets."

Bird Enemies of the Desert Locust.

THE part which birds play in the reduction of the damage caused by Locust visitation is a debated question. An article in the *Indian Journal of Agricultural Science* for October 1931, by Afzal Husain and Hem Raj Bhalla, gives definite evidence as to the status as locust destroyers of 35 Punjab species, the observations being made in Ambala District during the Locust visitation of 1930. Important enemies of the locust are :—The Common Indian House Crow, the Rosy Pastor, the Common Myna and the Northern Grey Partridge, but no less than 19 species were recorded to be of major importance. The paper contains further information of interest on the food of the birds mentioned.

Morphology of the Sporophyte of 'Riccia Crystallina'.

[F. M. Pagar, *Bot. Gaz.*, XCIII, 1.]

STAGES just before and after fertilization were observed in the development of the sporophyte of *Riccia crystallina* and up to the formation of spore-mother cells. No noteworthy peculiarities were observed. The spore-mother cells were surrounded by abundance of food material which is derived from the neighbouring cells. During the formation of the spores some of the potential sporogenous tissue will be 'diverted' much later than in *Marchantia polymorpha* and *M. domingenesis*..... The sterile cells thus formed are found not only at the periphery but also in the interior of the sporogonium and thus may be considered as the forerunners of the elaters of the higher forms Liverworts.

Spin of the Photon.

BHAGAVANTAM (*Ind. Jour. Phys.*, Vol. VII, pp. 107–138, 1932) has conducted measurements on the intensity and polarization of the Raman lines of hydrogen. He finds that the intensities in the horizontal components of the P and R branches are in conformity with the values given by the quantum mechanical calculations of Manneback while those of the Q branch are considerably less than the calculated values. This anomaly has been traced to the omission of taking into account the photon spin and revised calculations are shown to give results agreeing with experiment.

Cabbage as a Goitrogenic Agent.

IT has been found, in McCarrison's Laboratories at Coonoor, that cabbage when it forms the exclusive food of rabbits is capable of causing hyperplastic-goitre ; thus confirming the observations of Webster, Chesney, Marine *et alia* (1928) made in the United States of America. At Coonoor it has been shown that the goitrogenic potency of cabbage varies with season, being greatest during and after the "rains" and least (or nil) during the dry season in that locality. The goitrogenic potency of cabbage is enhanced by the addition of bran to the 'cabbage diet' and diminished by the addition of fresh green grass or carrots. It is enhanced also by the addition of sodium chloride or of radiostoleum and diminished by the simultaneous administration of iodine, thyroxine, manganese chloride or thymol. The action of cabbage is specific for the thyroid gland ; no other organ of the body appears to be affected by it. The thyroid enlargement caused by an exclusive diet of cabbage is associated with a significant increase in pH of the gland (7.05 as compared with 6.90 in well-fed controls).

Certain cereals are also goitrogenic when they form the major part of the dietaries given to albino rats : whole wheat is the most potent in this regard, polished rice the least potent.

The demonstration of the existence in certain food-materials of positive agents

inducing hyperplastic changes in the thyroid gland is an advance in knowledge of thyroid derangement of great interest. (*Ind. Jour. Med. Research*, XVIII, No. 4, April, 1931.)

Micrisporogenesis and Embryogeny in certain Species of Bromus.

[Percilee Beck and Jeorme S. Horton, *Bot. Gaz.*, XCIII, 1.]

THREE Californian species of *Bromus villosus* Frosh., *B. marginatus* Nees and *B. rubens* L., were studied by the authors. The material was fixed in Carnoy's reagent, and embedded in nitrocellulose according to Jeffrey's method. *B. marginatus* is an octoploid and *B. rubens* is a tetroploid, the chromosome numbers being 28 and 14, counts taken at heterotypic metaphase and Diakinesis respectively. *B. villosus* exhibited at the above stages 28–35 chromosomes, thus rendering it difficult to state whether the species is octoploid or decaploid, since the basal haploid number is 7 in the Gramineæ. "Lagging Chromosomes" have been observed in all the three species and very much lagging and extrusion occur in irregular homœotypic division in *B. villosus*. Chromatin extrusion leading to the clearest example of Polycarpy in as early as Diakinesis stage has been noticed. The megasporogenesis and the development of Embryo-sac appear to be typical of Gramineæ.

Studies on Chemical Needs of Amœba Proteus: A Culture Method.

[Hahnert William F., *Biol. Bull.*, LXII, No. 2, 1932.]

ATTEMPTS to grow animals in synthetic inorganic solutions have been very few and a study of Amœba proteus has yielded very interesting results. The animal grows and reproduces in a balanced salt solution containing salts of Calcium, Potassium and Magnesium. The results obtained indicate that the presence of Sodium is unnecessary and even detrimental to the growth and reproduction of Amœba proteus.

Determination of e/m by Electron-Diffraction.

[*Annalen der Physik*, 5th series, **13**, 725, 1932.]

MESSRS. R. Von Meibom and E. Rupp have calculated h/e, assuming de Broglie's relation $\lambda = \frac{h}{m_o v}\sqrt{1-\left(\frac{v}{c}\right)^2}$ and directly measuring the velocity of fast electrons, about 50 kv., by Wiechert's method as modified by F. Kirchner, and determining the wave-length by the diffraction of these electrons by gold. Previous determinations depended upon finding the velocity by means of the voltage-drop through which the electrons passed, and their accuracy was limited by that of the measurement of high voltages. The most accurate measurements of this sort were those of M. Ponte (*Ann. de Physique*, **13**, 395, 1930) who reached an accuracy of 3 per thousand in the case of ZnO. In the case of fast electrons (up to 250 kv.) de Broglie's relation could be verified to within 1 per cent. But by directly measuring the velocity of the electrons and using Kirchner's accurate value of e/m_o, *viz.*, $1.7585 \times 10^{-7} \pm 0.7$ per mille, the present authors obtain $h/e = 1.3798 \times 10^{-7}$ erg-sec. [est emg sec]$^{-1}$ with a mean error of ± 3.1 per mille. For comparison they have also given the following values obtained by other methods :—

(1) From the limiting frequency of X-rays : 1.3714 ± 0.5 per mille.

(2) From the photo-electric effect in metals : 1.3705 ± 1 per mille.

(3) From electron impact : 1.37515 ± 2 per mille.

The Industrial Outlook.

Improvement of the Indigenous Sugar Industry.

THE manufacture of white sugar by indigenous methods is an old established industry in India. Although, under the stress of competition from sugar produced by Indian and foreign factories, the industry has become restricted during recent years, it is still much larger than the Indian factory industry, as it accounts for over five times the quantity of cane used for the manufacture of sugar in factories.

It is of still greater importance in relation to the agricultural system particularly of the United Provinces and, possibly, in the near future of the Punjab. The *Khandsaris*, being small-scale concerns, are able to operate in the large areas in the interior where lack of communication, or scattered cultivation, makes the establishment of central factories impossible at present. If the *Khandsari* industry were to disappear, cane cultivation might become greatly restricted and the installation of central factories later on will be much more difficult.

Furthermore, the cost of production by the *Khandsaris* is not high. As the Tariff Board points out, "Overhead charges are low and the cost of supervision negligible, and this to a considerable extent makes good the loss incurred by low extraction. Capital cost is estimated at 6.79 annas per maund of cane crushed as against Re. 1 per maund of cane crushed in Centrals."

Appreciating the importance of the *Khandsari* industry and realizing that it will in any case be a long time before the factory industry of this country will have developed sufficiently to displace the indigenous and the imported sugar, the Imperial Council of Agricultural Research took up the question of improving the industry.

Experiments were conducted under the auspices of the Research Council at Bhopal in 1930, and at Bilari (Dt. Moradabad) in 1931, for the purpose of testing under commercial conditions the existing methods of sugar manufacture by the Open Pan process. Proper chemical control and regular commercial accounts were maintained so as to obtain a true picture of the efficiency of the processes involved and the soundness of the industry from a business point of view. Useful technical and commercial data have thus been collected, which, together with suggestions for improvement are embodied in the Scientific Monograph No. 3 of the Imperial Council of Agricultural Research, entitled "The Open Pan Process of White Sugar Manufacture", by R. C. Srivastava, Sugar Technologist, Imperial Council of Agricultural Research, India, Cawnpore.

B. C. B.

Science News.

ACTING on the recommendation of their Locust Research Committee, the Imperial Council of Agricultural Research have extended the scheme of research on the life-history, bionomics and ecology of the Desert Locust (*Schistocerca gregaria*), and a study of migrations and of control measures. An interesting development of the scheme which was started in 1930 at a cost of Rs. 1,76,000 is the establishment of a branch laboratory at Pasni, with two observation posts on the Baluchistan Coast. Following immediately on the Locust visitation of that year, the work was begun in October 1930, and since then much valuable information has been collected.

* * *

The Rockfeller Foundation has given a grant to the Government of Mysore which will be devoted to special studies on the viability of hookworm and other possible deleterious forms of life and also the careful study of the conditions under which nitrogen fixation takes place during the compost fermentation.

* * *

Under the auspices of the Institution of Sanitary Engineers, Mr. R. D. Anstead, M.A., C.I.E., formerly Director of Agriculture, Madras Presidency, delivered a lecture on "Activated composts, Agricultural wealth from waste". During the course of the lecture, reference was made to the recent work in India and photographs of the operations in Mysore and Bangalore were shown. A sample of compost made at Bangalore was also exhibited.

* * *

Under the auspices of the Society of Biological Chemists (India), Miss E. D. Mason of the Women's Christian College, Madras, read a paper on "Some Aspects of Racial Physiology" on the 30th June 1932. The lecturer described the results of some of the experiments she had carried out on the relative vital capacity and basal metabolism of South Indian subjects, mostly college girls, and came to the conclusion that the South Indian woman was 17 per cent. lower in

lung capacity than the American. The basal metabolism also was lower. The effects of climate and diet are under consideration. The factor that influences protein absorption is being studied by her. She suspected that chillies might have some effect but failed to find any. She found that the average South Indian relaxed more easily than the average Westerner.

Reviews.

The Waste Products of Agriculture. By A. Howard and Y. D. Wad, pp. xiv and 167. (London: Oxford University Press, 1931.) Price 7/6 net.

A valuable contribution to an important aspect of agriculture, particularly in the tropics. Written in flowing style and neatly printed on good paper the book makes excellent reading.

The earlier chapters are devoted to the elaboration of principles underlying the need for an increasing supply of well rotted, organic matter and the best method of securing the same. The authors then proceed to describe their Indore method which is presented in the minutest detail. Various observations relating to the nature of the composting materials, nitrogen, air and water are recorded. Possibilities of extending the method to other areas are also outlined. The text is supported by a series of appendices dealing with different aspects of manurial and related problems of which the most interesting is Mr. Howard's contribution to the organization of labour at Indore.

The book would appear to have been written mainly for the interest of the general reader, the benefit of the farmer and the direction of agricultural organizers and demonstrators. The mode of presentation is, however, such that even the most intelligent of laymen would be somewhat puzzled by the free use of technical terms, the severity of the details and wonder whether he could ever dare to improve on the Indore method! To the scientist interested in the compost problem the book is a disappointment. One notes with dismay that there is no mention of the extensive series of researches that led to the logical development of the Indore method; the observations that led to the preference of the pit to the heap; the choice of the nature and proportion of the various ingredients that constitute the biochemical starters of the fermentation; the need for the observance of the various minute details relating to the making of the heap, watering and turning; and the interpretation of the chemical and biological significance of the various observations recorded. The bibliography is not quite so complete as one would expect. There is, besides, an unusual tendency to exalt American work and under-rate or ignore the earlier and more fundamental English researches.

V. S.

Biochemical and Allied Research in India (1931). Society of Biological Chemists (India), Indian Institute of Science, Bangalore.

That the study of biochemistry and allied subjects is expanding in India is fully borne out by the Review of the progress of Biochemical and Allied Research in India, issued by the Society of Biological Chemists (India). This is the second publication of its kind issued by the Society. The first one issued in November last, reviewing the work done during 1930, contained references to 97 original papers. The second issued early in the May of this year contains more than 180 references. It redounds greatly to the amount of work done in India in this most important field of science. The Society has, since its inception two years ago, been doing useful work and the review is one of its most distinguishing features. The review has been divided into 11 sections out of which two sections, *viz.*, Animal Parasitology and Plant Pathological Chemistry, are new additions to the sections found in the first issue. A concise and up-to-date account of the work done in the several branches of Biological Chemistry has been presented in a very neat manner and the Society is to be congratulated on the very valuable work it has been doing. We await further publications of the Society which have been promised in the form of memoirs on important biochemical subjects.

K. S. V.

Coming Events.

Sixth International Botanical Congress.

ACCORDING to a decision by the Fifth International Botanical Congress at Cambridge in 1930, the Sixth Congress will be held in Holland in 1935. An Executive Committee has been formed, the President of which is Professor Dr. F. A. F. C. Went (Utrecht), while Professor Dr. J. C. Schoute (Gronningen) will act as Vice-President, Dr. W. C. de Leeuw (Bilthoven) as Treasurer and Dr. M. J. Sirks (Wageningen) as Secretary. The Committee has decided that the Sixth Congress will meet at Amsterdam, September 9th–14th, 1935. Scientific Societies are kindly requested to reckon with these data in planning their own meetings.

South Indian Science Association, Bangalore.

LECTURES (Central College).—

20th July, 6-30 P.M.
"Some Aspects of Tea Manufacture" by Mr. B. N. Sastri, Indian Institute of Science, Bangalore.

6th August, 6-30 P.M.
"Calcium Physiology" by Dr. C. V. Natarajan, Superintendent, Public Health Institute, Bangalore.

22nd August, 6-30 P.M.
"Vegetable Ghee" by Mr. P. Ramaswami Ayyar, Indian Institute of Science, Bangalore.

Society of Biological Chemists (India).

(Indian Institute of Science.)

LAST week of July.
Symposium on "Rôle of Organic matter in Soils".
President: Dr. Gilbert J. Fowler, D.Sc., F.I.C.

Notice.

IT may be remembered that in August last Dr. M. O. Forster, Director, Indian Institute of Science, Bangalore, issued a questionnaire with a view to elicit the amount of support which an Indian Science News Journal on the plan of "Nature" would receive from scientists and scientific institutions in the country. The response being very encouraging, the matter was placed before a meeting of the Indian Science Congress members early this year. The need for such a journal was unanimously admitted and a Working Committee was constituted to work out details. The Working Committee, after considering the position at several meetings and in consultation with scientists in different parts of the country, decided to issue the journal as a monthly under the name of "Current Science".

The Journal will be published with the editorial co-operation of a number of scientists in India. Prominent among those who have promised assistance are:—

Rao Bahadur L. K. Ananthakrishna Ayyar, B.A., L.T.
Dr. Baini Prasad, D.Sc., F.R.S.E.
Dr. S. S. Bhatnagar, D.Sc.
Mr. B. C. Burt, C.I.E., M.B.E., B.Sc.
Prof. Charles Forrester, F.I.C.
Dr. L. L. Fermor, O.B.E., D.Sc., F.G.S.
Dr. J. C. Ghosh, D.Sc.
Rai Bahadur S. R. Kashyap, B.A., M.Sc.
Col. R. McCarrison, C.I.E., M.D., D.Sc., F.R.C.P.
Rao Bahadur B. V. Nath, F.I.C.
Dr. C. W. B. Normand, M.A., D.Sc.
Dr. H. Parameswaran, D.Sc., F.Inst.P.
Sir C. V. Raman, D.Sc., LL.D., F.R.S., N.L.
Dr. K. R. Ramanathan, M.A., D.Sc.
Dr. M. N. Saha, D.Sc., F.R.S.
Dr. B. Sahni, D.Sc.
Dr. B. K. Singh, Sc.D., F.I.C.

The main features of the Journal will be:—

1. *Editorial.*
2. *Special Articles.*
3. *Letters to the Editor* consisting of short notes of original investigations.
4. *Research Notes* consisting of news and references to important publications, announcements and similar topics.

5. *Science News* consisting of news and notes of lectures, addresses, meetings, important scientific events, etc.
6. *The Industrial Outlook* consisting of notes and articles on industrial topics including all branches of applied science.
7. *Coming Events.*
8. *Reviews of Books.*

The Journal will be conducted by the undermentioned Board of Editors :—

Dr. F. H. Gravely, D.Sc., Superintendent, Government Museum, Madras.

Prof. C. R. Narayana Rao, M.A., L.T., Professor of Zoology, Central College, Bangalore.

Dr. V. Subrahmanyan, D.Sc., F.I.C., Professor of Biochemistry, Indian Institute of Science, Bangalore.

Rao Bahadur B. Venkatesachar, M.A. Professor of Physics, Central College Bangalore.

The annual subscription has been fixed at the low figure of Rs. 6 to enable every one interested in Science to subscribe fo the Journal. The price of single number will be As. 12.

The Board of Editors will be ver thankful if scientists in India and abroa will be so kind as to co-operate with ther by sending contributions of the natu outlined above and by enlisting themselve as regular subscribers.

Intending members are requested t communicate with the Secretary, "Curre Science", at an early date, to ensure supply of the Journal from the date (commencement of its publication.

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N.B.—Contributors and Advertisers—please see notice in the inside cover of back page.

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Unemployment among the Educated Classes.

ADDRESSING the graduates at the Convocation of Agra University in 1931, Sir Ross Barker is reported to have observed, "You are like apprentices who have collected the tools of your craft. You will be judged by the way in which you will use them in after life and as you are judged the University which has equipped you will be judged." In his very commendable exhortation Sir Ross Barker evidently assumes that there is a reasonable scope for the employment of the labourer and the exercise of his tools and therefore the responsibility of using them for a high and honourable purpose belongs to the young men. The significance of these pregnant words, had they been spoken thirty years ago, might have been understood by the graduates, when the harvest was rich enough to provide employment for tools and labourers of all description. Everyone knows that to-day the output of graduates from the Universities in India is out of all proportion to the expansion of public service, industrial organizations and other big employing agencies, and the rate at which the volume of unemployment among the educated young men is increasing must fill all thoughtful minds with apprehension. It is true that the acuteness of unemployment among the labouring communities is already straining the resources of statesmanship and possibly, in this case, at least partial relief may be given by rationalizing industries and by balancing agriculture and manufactures: but surely none of these palliatives can convey hope to the educated youth whose distress is as acute as it is widespread. That a compulsory restriction of the growth of population may be relied upon to bring succour, is, in our opinion, a suggestion more facetious than feasible and no far-sighted statesman can deem his stewardship fully and satisfactorily discharged until he has contributed to the solution of the problem which sooner or later is bound to become a menace to the stability of society and the progress of the

country. To argue that the scope of the problem is world-wide and is a fit subject for the League of Nations is to betray a defeatist mind. The intricacies which beset the subject are no doubt numerous but cannot be insuperable, and should not baffle a speedy and satisfactory solution in India.

To a large extent, the Government is responsible for the creation of the present unhappy situation. Though the authors of the Education Despatch of 1854 did not intend that the University examinations should be accepted as the sole test qualifying for admission to public service, yet, in actual practice, the Government placed a most touching confidence in the University credentials and eventually succeeded in firing the ambition of the educated Indian youth to look upon administrative posts as the main purpose and aim of their life. It is readily perceived that the qualifications most necessary for the proper discharge of official duties are not precisely those tested by the public examinations and putting a premium on the University diplomas and certificates virtually therefore amounted to ignoring in the young recruits qualities such as moral character, physical fitness and the power to handle men and affairs with ability and tact. It is only in India that the University graduates (even for clerical posts till recently in Madras) are admitted unhesitatingly to almost any position in the public service. This policy of Government while it encouraged the establishment of more colleges, exercised at the same time a sinister influence on the Universities which subordinated their higher purpose (to conserve knowledge, to acquire more and to disseminate it) to the demands imposed upon them by the exigencies of public administration. The obviously unfortunate association of success in public examinations and appointments to administrative posts, produced three undesirable results: the government got men trained not for life but for examinations, the Universities specialized not in learning but in examinations and the young men in several thousands staked their all on a game of chance. So long as the majority of these young men came from communities, who, by birth, training or traditional liking and ability, possessed a greater aptitude for the sedentary labours of the desk than for practical careers in commerce, industries and other professions involving business instincts, the problem of unemployment among the educated classes was well within bounds. It has assumed a distressing magnitude, since, as a result of the awakening of the political consciousness of the people, almost a fierce scramble set in to secure government posts. This zeal, orginally stimulated for constructive national work, has, in misapplying its energies, contributed greatly to the troubles of a situation already sufficiently embarrassing. The power of absorption on the part of the Government has reached a saturation point and cannot expand in proportion to the output of graduates. The solution is fraught with delicacy and difficulty and the suggestions made here for providing alleviation are intended to invite a critical and frank examination of the complexities of the problem which, in any case, ought not to be permitted to become chronic in the public affairs of the country.

The root of the problem seems to be the maladjustment of the aptitudes of the young men to the requirements of the professions which they seek to enter, and its acuteness is perhaps due to want of a clear appreciation of the fundamental difference between the rights of an individual as a principle and his inherent powers to give effect to them in actual practice. The law of variation of types governs and adjusts the conditions of the economic life of a country and it is advantageous therefore to establish at different grades of instruction, means for the self-differentiation of young men for careers for which they possess an in-born aptitude. This prevents wastage and secures a more equitable distribution of budding talents over a wider field of human endeavour. If the whole process of education in India were a mode of differentiating talents, instead of flattening them to conform to a unified undesirable pattern, then the practical results to the communities would be beneficial and unemployment among young men would be inconsiderable.

On the other hand, the educational institutions are turning out a large number of misfits in life; young men, who possess special aptitudes to develop their parents' occupation, desire to enter government service; others who are not permitted to enter service for reasons other than qualifications, desire to take to practical careers for which they have no talents. The ideal of the educated young men ought to be to exalt labour, whether it is that of the desk or of the plough; its underlying worth is its usefulness to the community and its dignity is measured by sincerity and honesty.

It seems to us that the first step in the solution of the problem of unemployment among the educated youth of India is for all the educational institutions to give up the egregious doctrine of their power of transmutation of talents and for the Government to cease to regard university credentials as necessary passports to employment. If the Universities were freed from this burden of providing young men for public administration, they would proceed with their more legitimate functions and no longer expose themselves to the criticism that they are responsible for unemployment. The Government, on the other hand, should have, through the Public Service Commissions or other agencies, recourse to methods of selecting recruits, the basis of such selection being the possession of general education and qualifications calculated to promote the administrative efficiency and enhance the purity of service. Perhaps the second step in the solution of the problem is an increasing recognition on the part of the Government and the people alike, of the fact, that the only moral justification for expending money on the education of the youth, is that as a result of such education they acquire the necessary power and skill to improve the vocations of their fathers and possibly devise new methods of enlarging them, due provision being, however, made for those young men coming from such homes, who may possess a distinct literary or scientific turn of mind. The practical fruits of education must be the creation of more wealth in the country and the educated youth in going back to the professions to which they are born, are the real producers of such wealth.

Suggestions have been made repeatedly by public leaders, that a great part of the solution of the problem of unemployment lies in giving education a "vocational bias". Apart from the intial cost, the success of this experiment depends upon a number of factors like traditional aptitude for craftsmanship, capital for establishing new industries on a small scale or to improve the old ones and protection of markets from an undue pressure of foreign competition. Besides the absorption of young men in the professional callings of their fathers, the more gifted among them must find new openings in industries, commerce and business combines equipped with technological and statistical laboratories. It would be most wasteful of time, labour and money if the young men specially trained for a definite practical career were to be drafted into clerical posts under government service or if those who have no aptitude for such technical professions should be forced into them under economic pressure. One of the reasons why the experiment of Agricultural Colonies for graduates has not become popular is that they were intended practically for those who possessed no hereditary instincts to such avocations and others who possessed them were drafted into administrative posts where they had to acquire aptitudes new to their traditional abilities and likings. To stop this waste of human talents produced by forcing men into callings adverse to their fullest developments, whatever may be the social theories in its support, would mark the beginning of a new era of economic prosperity. There are several minor side-industries which an young agriculturist equipped with practical biological training, might develop, such for instance as cattle-breeding (including dairy-farming), fruit growing and preservation of fruits, sheep-rearing, poultry-farming and apiculture. Prejudices and false notions of dignity of labour are a serious handicap, the removal of which ought to provide relief to unemployment.

Further, if India is not made safe for talented educated Indian youth to enter any

branch of service under the administration of the Imperial Government including the Army, the Navy and the Church,—provided they possess the requisite qualifications,—and recruitment elsewhere for these services does not stop, it is feared that the canker of unemployment will slowly undermine the very structure of the body politic, tending towards extremely undesirable manifestations. The Indianization of railways is a matter of extreme urgency and will provide employment to a large body of duly qualified Indians. To a very great extent, the solution of the problem in India is bound up with prejudice and vested interests, which have promoted its acuteness. The tools and the labourers to which Sir Ross Barker referred in his Convocation address are there, and are not unworthy; but the expansion of the field for the employment of both is the province of statesmen, the great industrial and commercial magnates, the landed aristocracy and business corporations.

Chemistry and Currency.

By Dr. Gilbert J. Fowler, D.Sc., F.I.C.

TO the Biochemist the phenomena of life present a wonderful picture of energy transformations, controlled by marvellous mechanism, and in all their complexity conforming to fundamental quantitative law.

Thus, for every intake of food there is a definite output of energy, either in the form of physical or mental work, or of heat.

This is becoming well recognized by up-to-date food vendors and manufacturers, and the careful housewife, especially if she is American, calculates and adjusts her menus in calories. On the door of the weigh-house, at the entrance to the Mysore City sewage farm, is a list of the vegetables sold, and their corresponding energy values, expressed in calories.

In the last annual Memoirs and Proceedings of the Manchester Literary and Philosophical Society, which has just come to hand, there is an interesting reprint of a short autobiography of Dr. J. P. Joule, which has recently come into possession of the Society, in which he states that in 1841 he found that, "the quantities of heat evolved by the combustion of the chemical equivalents of bodies are proportional to the intensities of their affinities for oxygen." Thus Joule may be said to be the father of modern quantitative dietetics.

Long before the date of Joule's discovery Adam Smith wrote as follows in "The Wealth of Nations":—

"Labour alone, therefore, never varying in its own value, is the ultimate and real standard by which the value of all commodities can at all times and places be estimated and compared. It is their real price; money is their nominal price only.....

"The real value of all the different component parts of price, it must be observed, is measured by the quantity of labour which they can, each of them, purchase or command. Labour measures the value not only of that part of price which resolves itself into labour, but of that which resolves itself into rent, and of that which resolves itself into profit.....

"Food is in this manner not only the original source of rent, but every other part of the produce of land which afterwards affords rent derives that part of its value from the improvement of the powers of labour in producing food by means of the improvement and cultivation of land."

Have we not in the work of Joule a means of measuring exactly the labour which Adam Smith declares is the only true basis of value?

Here let us at once guard against a misconception. Adam Smith never intended to say that the *value* of each man's labour was the same, but that it constitutes a *standard* by which the value of other commodities can be measured. Adam Smith sensed the fundamental fact which the work of Joule put into scientific form that

every adult individual requires a certain minimum amount of food in order to be able to expend an equivalent amount of *energy*. How that energy may be applied is another question; a dynamo may turn out so many units of electrical energy per hour, which may be expended in lighting a room or in firing a mine, the amount of energy may be the same in both cases, the effects are different. Therefore, both "Poet and Peasant" require, within certain limits, the same amount of daily food, but the energy set free may be expended in the one case in writing poems on the delights of a rural existence, and in the other in actually digging potatoes for the poet's sustenance.

Considerations such as the above have led to the idea of a fixed datum for currency, based, not on metal, but on *Energy*, combined with the most constant element in the human food ration, *viz.*, *Nitrogen*. This datum has been termed the ERN, from "Erg" the unit of energy and N the symbol for nitrogen.

The daily nitrogen ration, according to Professor Rose of the University of Illinois, (Dietary Facts and Fads, *Ind. and Eng. Chem.*, June, 1931) is 10 grams, and the equivalent energy 300 calories. The actual value of one ERN on this basis is therefore 300 calories multiplied by 10 grams of nitrogen.

Nitrogen is chosen as a basis because, of all the constituents of the total food ration, its consumption fluctuates within the narrowest limits, 10 grams per capita per day representing a fair average.

An obvious criticism is that all kinds of nitrogen compounds are not of the same nutritive value, but in actual practice, nitrogen as a commodity has its average price, which is controlled by the quantity available and the demands of agriculture. The elemental nitrogen, as it originally exists in the atmosphere, may properly be taken as a basis, since it passes during its cycle from the air to the nitrogen-fixing bacteria in the soil, from them to the plant, from the plant to the animal, and back again to the soil, whence by reason of sundry denitrification changes, it again assumes its elemental condition, and passes back into the atmosphere. During this cycle it has entered into countless different combinations, the resultant energy of which, liberated as they pass through the human body, averages some 300 calories per day.

Having once decided upon the value of this basic datum, the ERN, in terms of normal currency in a year of average prosperity (1928 has been suggested), the value of all other commodities can readily be calculated in terms of ERNS. In a recent speech, Mr. Winston Churchill states that the prices of thousands of commodities have kept in step with one another, gold alone has broken the ranks.

With the ERN as our standard we should have a constant basis for our commodity prices.

The ERN does more than this. Owing to the two interdependent factors, energy and nitrogen, it provides a means for equating mechanical power and agriculture. The machine is only an extension of a man's hand. One man, kept alive by food purchased by so many ERNS, can operate a machine liberating units of energy in abundance. The labour and intelligence of man can harness the Cauvery Falls and light up the towns and villages of the Mysore State. The energy thus utilized represents so many ERNS. On the other hand, without the nitrogen, provided by the labour of the agriculturist, the man at the machine cannot function. The combined value of the food and of the energy which this sets free, either immediately or ultimately, constitutes the *real* wealth of the State. This is living wealth. Gold is *dead*. What can it *do* in "its long, indirect and solemnly idiotic journey to be sterilized in the vaults of the hoarding powers"? (H. G. Wells, "*The Work, Wealth and Happiness of Mankind*," p. 381.)

With the ERN as our standard of currency there would ultimately be no need to hoard. So long, as the sun shines and the sea endures and the intelligence of man has free scope, he has wealth and to spare in the forces which he has at his disposal.

As Professor Soddy reminds us—"with the doctrine of energy, the real capitalist proves to be a plant" ("*Wealth, Virtual Wealth and Debt*," p. 30.)

The practical measures necessary to introduce an ERN currency, and the social and political results which would follow, may well provide subject-matter for further articles.

The Future of Agriculture in India.

THE importance of Agriculture to India has been realized to a greater extent during recent years than at any other time in the history of the country. The report of the Royal Commission (1928) presents a searching enquiry into the various problems at issue and the best means of solving them: the Imperial Council of Agricultural Research constituted on their recommendation has continued their good work and has already rendered valuable service to the country. Various new schemes have been sanctioned and researches leading not only to increased yield but also to improved quality undertaken. The provincial agricultural departments, as also those of the Native States, have also redoubled their activities and chiefly as the result of their efforts combined with those of the irrigation departments, larger areas are coming under cultivation, more valuable crops are displacing the cheaper ones and superior and high-yielding varieties are taking the place of the inferior strains. All these would augur well for the prosperity of the country—richer harvests and larger returns for the farming classes, cheaper and more plentiful food and clothing for the others and increased trade and wealth for the nation. Is such really the case? If not, what is our present position and what are we heading towards?

A study of the trade returns* for the past few years would show that the prices of agricultural produce have been steadily falling and that the exports made up chiefly of textile fibres, food grains and oil seeds have already shrunk by nearly 50 per cent. There is financial distress all around and the suffering, particularly among the agricultural classes, who constitute 75 per cent of the total population, more acute than ever before. Is the present depression a momentary one caused by fluctuations in currency and political troubles or is it a more serious condition likely to lead to further distress unless new remedies are found?

The position would be clarified when it is realized that the present agricultural awakening is not confined to India alone: in fact, other countries had started long before India began. Starting with Sir William Crookes,* a succession of authorities had predicted food shortage in the World unless more is produced; even recently, Sir Daniel Hall† has expressed profound uneasiness at the inadequacy of the present supply to meet the growing needs of Western countries. The experiences of the War have also taught many a country to be independent of the others for their food and clothing. As the result of the above we find almost every country in the World producing more than it ever did before.‡ Export trade in agricultural crops has shrunk and countries like India which have subsisted mainly on the produce of the land have been seriously hit. There is yet no suggestion of acute over-production except in the cases of rubber and tea but such a condition is bound to extend beforelong, to other crops as well.

Before considering any remedial measure it would be essential to determine whether there is any real cause to fear shortage of food supplies at least in the near future. Taking merely the cultivable lands into consideration, we find that only a small fraction of the World's extensive areas have so far been brought under the plough. Thus, Canada has still over 350 million

* *Review of Trade in India*, 1928, **54**; 1929, **55**; 1930, **56**; 1931, **57**.

* *Repts. Brit. Assocn.*, 1898 (Bristol), 3.
† *Repts. Brit. Assocn.*, 1926 (Oxford), 255.
‡ *Int. Rev. Agric.*, 1928, **19**: 1929, **20**; 1930, **21**.

acres of potential farming land* and India over 100 million acres of cultivable waste† ; United States has still about 60 million acres eminently suitable for raising wheat ; Russia, Siberia, Australia, Argentine and South Afrcia, to speak of only a few, have also millions of acres which can be readily brought under cultivation. The above and other bigger countries of the World have so far found it paying to adopt the extensive system of farming according to which although large areas are brought under cultivation no special attempt is made to increase the yield per unit area. The experiences of small but self-contained countries like Belgium and Denmark have, however, shown that under the 'intensive' system of farming the yield per unit area can be increased at least four-fold. Assuming that a large part of the uncultivated areas come under the plough and that the intensive system of farming is adopted in many of the bigger countries, there would soon be enough food and clothing for at least four times the present population of the World so that there would appear to be no prospect of food shortage for at least a few centuries to come !

The general panic is, however, still there, as also the ambition to capture the hypothetical agricultural markets of the World. Europe has so far been the chief importer of agricultural produce from abroad, but there will soon be the danger of over-production in Europe itself ; indeed, as Speyer‡ has stated, if all the European countries are to adopt the use of moderate doses of nitrogenous fertilizers there would be no consumption for half the extra crop thus produced ! It would be obvious from the above that the demand for Indian grains would soon steadily decrease.

It may be argued that India may still hold her own in cotton, oil-seeds and other tropical products. The developments of the past few years§ have, however, shown that even there her position is not very secure. In addition to United States, there have now sprung up new rivals in Uganda, Sudan and Russia on the cotton market. In the oil-seed trade, West Africa and South America are steadily ousting India from the European market. Ceylon and Dutch East Indies have set up as serious rivals in tea. Russia has already monopolised the hemp trade and East Africa that in many of the spices. Brazil is already overproducing coffee and Malaya, rubber. There is yet no cause for serious alarm, but we cannot be blind to the possibility of further shrinkage in export trade and depreciation in the value of agricultural produce, thus resulting in general distress to the farming classes who form the bulk of the country.

What is to be the remedy ? Restriction of World's output would be a solution, but most countries will not adopt such a policy and even if they do, they will not follow it, so it will end disastrously to those countries that observe such a compact. Tariffs will, no doubt, protect the country from foreign products being dumped in and help by preferential treatment or otherwise to assist in the assimilation of raw materials by some of the manufacturing countries. Such a course will only be a palliative and will not save the country from internal overproduction and the consequent distress.

The real solution of the problem would be apparent when it is realized that whereas there is one method of producing a crop, there are several ways of utilizing the produce. India has so far been confining her attention to the production of raw materials rather than to the preparation of finished products. To one acquainted with inter-relation between things, agricultural products represent vast store houses of energy bound up with various types of sugars, proteins, fats and such basic principles from which most of the other products required for the comfort and well-being of mankind are derived. Yet, neither the farmer nor the country gets very little out of them. Taking just a few instances we find that almost all kinds of energy producing materials can be obtained by either

*Greig, *Repts. Brit. Assocn.*, 1929 (S. Africa), 230.

† Clarke, *Proc. Ind. Sc. Cong.*, 1930, **17**, 23.

‡ *Nature*, 1929, **123**, 54.

§ *Int. Rev. Agric.* (*loc. cit*).

fermenting or otherwise treating different plant products which now find practically no application: the products thus obtained can also be used as solvents in industry; they may be treated in a variety of ways and be made to yield numerous products required either in medicine or for various types of arts and manufacture. Thus, starting from some of the commoner vegetable materials it should be possible to prepare a number of alcohols, organic acids and esters; starches, gums, dextrins, different types of adhesives, distempers, etc.; paints, varnishes and enamels; disinfectants, antiseptics, insecticides and fungicides; essential oils, perfumes and cosmetics; various cellulosic materials including lacquers, mercerised cotton, artificial silk, and explosives; numerous dyes and pigments; various types of waxes, resins and allied products; numerous drugs and medicinal substances; and different digestive ferments used in medicine and industry. Even among articles of food there are various types of infant and invalid preparations, preserves, pickles, jellies and such like, all of which are in great demand in all the civilized countries of the World. The above are only a few of the numerous known methods of utilizing surplus agricultural produce; the efforts of the scientist combined with those of the industrialist can also produce several new ones so that the possibilities of such applications are almost inexhaustible.

The agriculturist and the industrialist, at any rate in India, have so far moved apart, the former being more interested in the disposal of his harvest than in utilizing them to obtain better returns and the latter, generally, in textiles and machinery. The time is now come for them to combine and utilize their resources to mutual advantage. Each is, however, yet unaware of the precise position of the other and it is for the Government to bring them together. It may not be too much to expect that realizing the importance of the problem, the Government would appoint a Commission composed of representatives of agriculture, forestry, industry and applied science to enquire into the matter and advise them with regard to the best means of bringing about active co-operation between the organizations concerned. The terms of such a Commission should no doubt include the exploration of means of maintaining the organizations concerned in continuous touch with each other's difficulties and the employment of a band of workers who will investigate the problems at issue in their proper perspective. A beginning can even now be made with (*a*) agriculturists, and industrialists holding frequent joint conferences to decide on the most suitable problems for investigation: (*b*) the Imperial Council of Agricultural Research including agricultural industries in the purview of their enquiries and setting aside a part of their funds for the furtherance of researches on that subject; and (*c*) the provincial agricultural departments having a special staff attached to their laboratories primarily for the investigation of methods of utilizing agricultural produce. Much more remains yet to be done; but a beginning of the realization of problems at issue will itself have the desired moral effect and go a long way towards the alleviation of the present distress among the agricultural classes and ward off many that might arise in the future.

Breeding of Trochus and Preservation of the Beds in the Andamans.

By C. Amrithalingam.

TOP or Pagoda shell (*Trochus niloticus* Linn.) occurs in abundance, within the five fathom limit, in the Andaman and Nicobar waters and has been fished for some time by various Japanese firms for the manufacture of paint, tooth paste, mother-of-pearl buttons, etc. It was only in recent years that the Andaman Administration was made aware of the economic importance of this fishery and so proceeded to take steps to establish it on a permanent basis. As the various stages of the life-history of this mollusc had not been investigated, it was found necessary to determine the breeding season, etc., before the *Trochus* fishing could be controlled properly. My work on the boinomics of this shell-fish revealed that it starts spawning in April and continues spawning till the commencement of the south-west monsoon.

From the inception of legalized shelling industry in the Andaman and Nicobar waters, the accepted season has been from 1st. October to 30th. April, *i.e.*, seven months. This year, according to my suggestion, while I was a Research Officer, Andaman Fisheries, the shelling season is expected to start on the 1st. September; I did not suggest a closing date as I had not then discovered the breeding season of *Trochus niloticus*. Now that it is known that this mollusc starts spawning in April, it is but evident that the fishing season should be closed on the 31st. of March.

By changing the fishing season from 1st. October–30th. April to 1st. September—31st. March, the breeding individuals will not be fished, and thus the beds will be saved from depletion; this suggestion, if accepted, will ensure the restocking of beds without any loss of the current revenue from this source, as shelling-season will last for the same length of time as in previous years.

On the Bombay coast too, Mr. Hardit Singh Rai* finds the necessity of observing a close season in the fishing of marine economic animals during the breeding period. It is evident, therefore, that in legislating for the control of marine industries in the Indian waters, special attention should be paid to the breeding period of the species concerned in much the same way as laws regulating Game Birds.

* *Jour. Bombay Nat. His. Soc.*, **35**, 834, 1932.

"The Rôle of Organic Matter in the Soil."

INAUGURATING the symposium on "The Rôle of Organic Matter in Soils," held under the auspices of the Society of Biological Chemists (India) on the 30th. July, Dr. Fowler, who presided, outlined the present position of the problem. The foundation of agriculture is soil fertility which is considerably influenced by the organic matter present in the soil. The extensive work of Howard in India definitely showed the vital importance of root aeration in relation to crops. Organic matter, by affecting the texture of the soil, effectively helps the aeration and moisture conservation in soil, thus providing optimum conditions for the micro-organisms to flourish; it affects the reaction of the soil, and the viability of the microflora especially the nitrifying and denitrifying organisms. The importance of the products of oxidation of organic matter in the soil is not to be ignored. There is again the famous auximone theory of plant stimulation put forward by Bottomley. The carbon/nitrogen ratio is a very acute question which has a bearing on the chemical aspects of the problem. Finally, the organic matter in the soil affects the vitamin value of the crop produced. He hoped that the several speakers would deal with these subjects and would materially contribute to our knowledge of the problem.

Dr. V. Subrahmanyan, discussing the microbiology of the decomposition of organic matter in the soil, outlined the essential factors concerning this aspect of the subject. The nature of the organisms, which are selected from the natural flora of the soil, are determined by the chemical composition of the organic material, soil conditions and climate. The mechanism of the slow conversion of dead microbial cells into plant nutrients, of which definite evidence exists, is obscure. Physical texture, aeration, light, moisture, reaction, treatment with minerals and system of cropping are factors that determine the nature and activity of the organisms occurring in the soil. There is yet no satisfactory method available for the study of the nature or activity of the microflora concerned in the decomposition of organic matter in the soil. Excessive quantities of organic substances are accompanied by marked change in the associated fauna and flora; bacteria are suppressed and a variety of pathogens develop. Either fallowing or partial sterilization by heat or antiseptics restores the soil to normal biological equilibrium. Among the many fundamental problems on the decomposition of organic matter in soil awaiting solution are, the standardization of conditions leading to economy of carbon and conservation of nitrogen, study of conditions leading to loss of nitrogen and those favouring fixation, the physiological transformations undergone by various putrefactive and pathogenic organisms associated with different organic materials applied to the soil, and steps to be taken to avoid sudden outbreaks of various plant and animal diseases.

Dealing with the chemical aspects of the problem, Dr. Mirchandani showed that there were still many gaps in our knowledge of the decomposition of organic matter in the soil. Of the several factors determining the decomposition, he considered C : N ratio of the organic matter as the most important. From the decomposition studies of many substances, individual as well as mixtures, of varying C : N ratio, he concluded that a ratio

16 was the most desirable one if benefit was be derived from the added organic matter; d the further the ratio was removed from the timum, the further was the period of nitrogen ficiency in the soil. The effects of narrow C : N ere also described and stress was laid on the ed for the proper regulation of the decomposi- on of organic matter by adjusting its C : N tio.

Mr. G. S. Siddappa, in presenting a paper on Organic matter as direct source of plant nutri- on", traced the history of the subject from 337 to date. It had been recognized from the rly days of agricultural science that organic anures were very beneficial to crops. There a school of opinion which holds that the effect of ecomposing organic matter is to provide addi- onal carbon dioxide for plant growth. This not entirely unchallenged. The exact history the rôle of organic matter as direct source r plant nutrition or stimulant dates from the nouncement of the "auximone theory" by ottomley and Mockeridge in 1912. The recent ork on the necessity of "bios" for the growth of east adds one more proof to the subject. This ibject has been the centre of keen controversy id numerous are the experiments done to phold or reject the theory. The evidence at resent points very strongly towards the truth the theory. Recent experiments at the Indian istitute of Science on the effect of injection extracts of yeast and farmyard manure on the owth of *Helianthus annus* has strikingly con- rmed the presence of plant stimulants in organic atter that influence the growth of plants quite it of proportion to their quantity. Further ork on the subject is being carried out.

Rao Bahadur B. Viswanath spoke on the elative advantages of the use of organic and ineral fertilizers. In India, the soil is remark- bly poor in carbon and nitrogen as compared ith European and American soils. The nportance of manuring soil is, therefore, much reater here than elsewhere. Graphs were shown, nd experiments conducted at Coimbatore were utlined to illustrate that organic manures have ery much greater effect on plant growth than iorganic mineral fertilizers. The effect of the rganic manure is more lasting and better. Al- ough the mineral fertilizer may show an advan- age in the earlier stages, these fall off slowly nd steadily so that finally the organic manure iumphs. The seeds obtained from plants grown n organic manure have a decidedly better nutri- ive value as shown by Col. McCarrison in his ietetic experiments on rats. The straw was lso found by experiments in Coimbatore to be f greater food value to domestic animals. he seeds, moreover, inherited the qualities of the arent crop in their quality and quantity of rowth. It is, therefore, very essential that we hould conserve our organic manures very care- ully and utilize them to the best advantage.

Mr. P. V. Ramiah contributed a paper on the earing of organic manures on animal nutri- ion. Cereals grown on cattle manure always ossessed higher nutritive values. This could iot be ascribed to higher protein content. In act there was less nitrogen in the grains grown n cattle manure plots. Vitamin assays of these grains were conducted both at Coimbatore and at Coonoor and showed that they always pos- sessed higher values. Plimmer has shown that the vitamin B content of a diet greatly influenced the nucleo-protein metabolism. This may be extended to other constituents of the diet and may be mainly responsible for the difference observed in these nutritive values. Thus, there is a close relationship existing between soil, plant and animal. By manuring the pasture lands with ammonium sulphate the amount of sulphur metabolized by the sheep grazing on them can be greatly enhanced thus leading to an increased output of wool. One could thus manure either for milk, wool or meat as is required.

Mr. Viswanath opening the discussion on the subject, took up the problem of plant stimula- tion. The experiments conducted at Coimba- tore showed that minute quantities of substances like yeast extract stimulated plant growth to enormous extent. Although Russell in his latest edition of the book on "Soil conditions and plant growth" still wrote that the influence of organic matter lies in its effect on the texture of the soil, the matter is not so simple as that. The work of Bottomley and later by Ashby and others point to the existence of certain plant stimulants which catalyse plant-growth and which function in the presence of micro-organisms. The relative results obtained with the use of yeasts, yeast and mineral fertilizer, mineral fertilizer alone and ordinary farmyard manure, showed that the best effect was obtained with yeast and mineral fertilizer and that yeast alone is much superior to other treatments. The grains from the stimulated ones, when sown, take up greater nutrition from the soil than the untreated ones. The yield of straw and grain is greater. The nutritive value of plant and seeds obtained by yeast stimulation was better than unstimulat- ed ones. The evidence points to a clear relation between vitamins and auximones, thus establish- ing a sort of cycle between animal, plant and bacteria.

Dr. B. Sanjiva Rao raised the point of the rôle of inorganic catalysts in the decomposition of organic matter in soil. Indian soils are noto- rious for the rapidity with which the organic matter is depleted from them and this is more so in the case of laterite soils, where ferric oxide is present, than in other soils. He suggested the possible rôle of ferric oxide as a catalyst in the decomposition of organic matter in soil.

Dr. Fowler drew attention to the experiments carried out at Rothamsted where it was defin- itely shown that small traces of boron have great effects on plant growth.

Mr. M. Sreenivasaya suggested the possibility of applying tissue culture methods in place of the usual pot culture ones for the study of these problems. He pointed out the economic importance of the necessity of finding out whether the qualities of seeds grown on organic manure persist for a few generations. He suggested that experiments on the activation of enzymes by yeast extracts like diastases in starch elaborat- ing plants and proteases in legumes could be advantageously tried to study the problem of plant nutrition.

Mr. A. V. Varadaraja Iyengar suggested the use of plants reared on a 'basal diet' on an analogy with animal nutrition experiments. The importance of the quantity of mineral fertilizers on the decomposition of organic matter should be considered.

Mr. B. N. Sastri pointed out the inadequacy of controls used in some of the experiments conducted and suggested the injection of ash constituents for the control plants. He drew attention to the fact that traces of inorganic constituents were known to stimulate the growth of plants, much in the same way as the auximones whose existence has been postulated.

A detailed report of the symposium will shortly be issued by the Society of Biological Chemists (India).

K. S. VARADACHAR.

Investigation of the Solar Corona without an Eclipse.

By Dr. K. R. Ramanathan, D.Sc.

THE study of the solar corona has been, till recently, confined to short intervals during total solar eclipses, when the overpowering light of the sun is shielded from the earth by the moon's disc. In a paper read before the French Physical Society by M. Bernard Lyot of the Meudon Observatory near Paris an experimental technique worked out by him was described which provides a new method for investigating the light of the corona at all times when the sky is sufficiently clear and thus gathering more knowledge regarding this outer extensive tenuous envelope of the sun.

The most important obstacles to the observation of the comparatively feeble light of the corona under normal conditions are: firstly, the scattering of light by the solid and liquid particles suspended in the atmosphere and secondly, the scattering of light by imperfections in the optical system of the instrument used in the observation. The scattering by the gaseous constituents of the atmosphere are of comparatively little importance.

The only way of getting over the first difficulty is to make the observations from a high-level station which lies well above the low-lying dust layers and at times which are comparatively free from atmospheric disturbances. Mons. Lyot made his observations from Pic der Midi in S. France with an elevation of 2,800 meters above sea-level. Using a faultless telescopic objective and stopping it down to about 4″ diameter, he formed an image of the sun on a blackened disc whose diameter exceeded that of the sun's image by a few seconds. Another lens placed behind the disc produced an image of the first lens on a diaphragm whose centre was occupied by a small opaque screen. The edge of the diaphragm cut off the light diffracted by the edges of the first lens and the small screen stopped the light of the sun's image formed by internal reflection from the faces of the first lens. A well corrected objective placed behind the diaphragm and screen formed an image of the corona.

Examining the image with an eyepiece the prominences could be seen round the edge of the sun with a rosy red colour. When the atmospheric conditions are particularly good, the corona also could be photographed using a red filter.

Placing the slit of a spectrograph tangential to the image of the disc, the red and green rays of the corona (6375 A and 5503 A) could be photographed.

It is hoped that by installing one of these instruments in a selected high level station, it would be possible to follow day-to-day changes of solar corona and investigate its relationship to prominences and sunspots and perhaps also to related terrestrial phenomena such as magnetic storms and the reflection of electric waves from the upper atmosphere.

Letters to the Editor.

[The Board of Editors do not hold themselves responsible for opinions expressed by correspondents. No notice is taken of anonymous communications.]

The Antimony Electrode in Soil Work.

THE antimony electrode has been under trial for some time in this laboratory in connection with the pH determination of soils. Various relationships have been obtained by different workers between electrode potential and pH value. Using Clark's series of buffer mixtures and an elctrode prepared from Kahlbaum's specimen of metallic antimony against the saturated calomel electrode (temperature 27°C) the following relationships were obtained for each of the ranges pH4—pH7, pH7—pH8 and pH8—pH10.

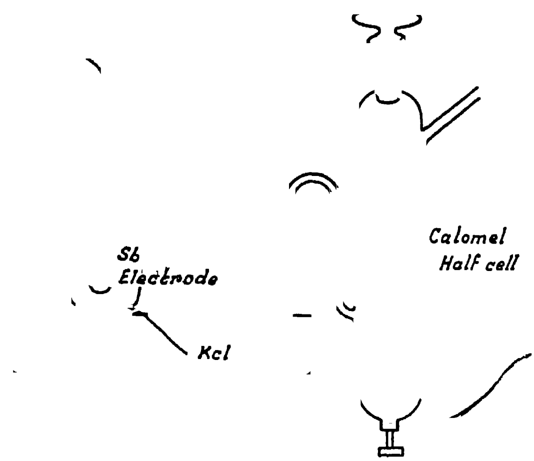
Range of pH	Equation connecting E with pH.
4—7	$pH=\frac{E-.0129}{.05530}$
7—8	$pH=\frac{E-.2029}{.02969}$
8—10	$pH=\frac{E-.0215}{.05288}$

Best* obtained somewhat different equations connecting E and pH.

The electrode was apt to behave erratically for several weeks after preparation but after stability had been established continued to behave consistently in conformity with the above equations.

For the determination of the pH of soils the following method has been found to be both convenient and satisfactory.—

A disc of filter paper cut to size is placed at the bottom of a gooch crucible and the latter three quarters filled with the sampled soil. The crucible with the soil is placed in a flat dish with enough water at the bottom to completely saturate the soil and the whole is left under a bell-jar over night. The soil is then transferred to a porcelain dish, thoroughly stirred with a glass rod or spatula and returned to the gooch after placing the disc of filter paper in position. The rest of the arrangement could be seen from the diagram below :—



The above arrangement ensures the wetting of the soil to its maximum saturation capacity, a condition which experience has shown is conducive to reproducible results being obtained.

Contact of the bottom of the crucible with the solution of potassium chloride which serves as the liquid junction is effected by a strip of blotting paper.

T. LAKSHMANROW.
Physical Chemistry Section,
Chemical Research Laboratories,
Agricultural Research Institute,
Coimbatore,
June 30, 1932.

*Best, *Jour. of Agri. Sc.*, 21, 344.

Mechanism of Respiration in Hill-Stream Fishes.

THE normal mode of breathing in a fish consists of an inspiratory and an expiratory phase. At the commencement of the former, the mouth is opened a little, and the external gill-openings are kept tightly closed. At the same time the hoop-like gill-arches expand, and consequently, there is an enlargement of the cavity of the

pharynx. As a result of these actions a stream of water is drawn into the pharynx. During the expiratory phase, which follows soon after, the mouth is closed tight and the pharynx is contracted. The water is thus driven out of the pharynx and, after passing over the gills, is expelled through the external gill-openings.

In the hill-stream fishes, in which the mouth is small and is situated on the ventral surface considerably behind the tip of the snout, this mode of breathing is hardly possible, firstly because most of these fishes lie closely pressed to the substratum, and secondly because the mouth is usually surrounded by broad lips which enable the fish to adhere to rocks and stones in swift currents. As a result of these modifications, the mouth is not in contact with any large

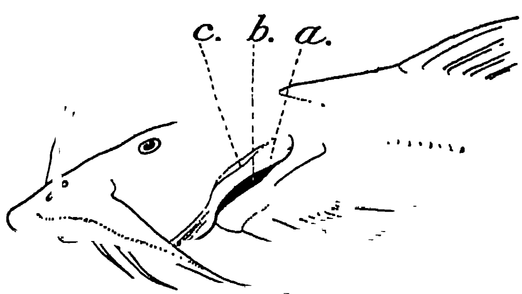


Fig. 1. Lateral view of Head and anterior part of body of *Glyptothorax pectinopterus* (McClelland). *a.* opercular flap; *b.* gill-opening; *c.* limit of the bony operculum.

quantities of water. In 1923,* it was observed by me that in *Glyptothorax*, *Pseudecheneis*, *Garra* and *Balitora* the mouth remains open throughout the process of respiration, and recently Mr. D. D. Mukerji has found that this is also true in the case of a totally different type of fish *Amblyceps mangois* (H.B.). It has been ascertained that in these fishes the respiratoy current is initiated and carried on by the vigorous pumping action of the opercular flaps. In the Indian hill-stream fishes it is the upper portion of the opercular flap that performs this function, whereas in *Loricaria* (Hora, 1932*) it is the lower portion that is specially modified for the same purpose.

This method of respiration in hill-stream fishes probably serves a double purpose. Besides the oxygenation of the blood, the pumping action of the opercular flaps sets up a strong current on the underside of the head of the fish when the water is sucked in through the mouth. The currents produced by the respiratory movements result in lowering the pressure on the ventral surface of the head and the animal is enabled to stick to the substratum more firmly (Hora, 1930).†

In certain highly specialized torrential fishes, such as *Gyrinocheilus of* Borneo and Siam and *Arges* of the Andes in South America, the mouth no longer serves as a passage for the inspiratory current, and the branchial openings are modified in a remarkable way. Each gill-opening is

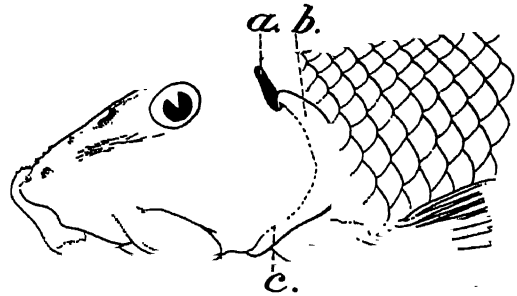


Fig. 2. Lateral view of Head and anterior part of body of *Gyrinocheilus kaznakoi* Berg. *a.* inhalent aperture; *b.* opercular flap of exhalent aperture; *c.* limit of the bony operculum.

divided into an upper slit-like portion, which serves as an inhalent opening and communicates with the posterior part of the mouth cavity immediately in front of the gills; and a lower much wider portion which serves as an exhalent aperture and is guarded by membranous structures. Vaillant,‡

* Hora, S. L. Observations on the Fauna of Certain Torrential Streams in the Khasi Hills. *Rec. Ind. Mus*, **25**, 591, 1923.

* Hora, S. L. Biological Notes on a Fish from Brazil in the Society's Aquarium. *Proc. Zool. Soc., London*, **205**, 1932.

† Hora, S. L. Ecology, Bionomics and Evolution of the Torrential Fauna. *Phil. Trans. Roy. Soc., London*, Ser. B. **218**, 258, 1930.

‡ Vaillant, L. L. Résultats Zoologiques de l'éxpédition scientifique néerlandaise au Bornéo central. Poissons. *Notes Leiden Mus.*, **24**, 108 (1902).

he author of the genus *Gyrinocheilus*, tributed the respiratory movements of this ısh to the expansion and contraction of he walls of the oral cavity, but Smith* ıas recently observed the vigorous movenents of the opercular-flaps—230 per ninute. I believe that in *Gyrinocheilus*, ıs in the other hill-stream fishes referred to ıbove, the respiratory current is initiated ınd carried on by the opercular-flaps of he exhalent openings.

The above is an instructive illustration of the influence of habit in the production of new forms. The habit of lying close to he substratum and of adhering to rocks by means of lips in hill-stream fishes has ltimately resulted in the modification of he entire respiratory mechanism.

SUNDER LAL HORA.

Zoological Survey of India,
Indian Museum, Calcutta,
July 12, 1932.

* Smith, H. M. Notes on Siamese Fishes. *Journ. Siam. Soc. Nat. Hist. Suppl.*, **8**, 187 (1931).

The Probable Cause of Cotton Root Rot in Gujerath.

THE Gujerath Root Rot of Cotton has been a mysterious disease so far. In last August when a laboratory was supplied o the Department of Agriculture here, it vas possible to find out the nature of this lisease. On putting the attacked roots ınder a moist chamber, the sclerotia swelled ınd produced pycnidia, in which elongat-d unicellular spores were formed. These esembled *Phoma* and the writer was under he impression that it was a *Phoma*. On onsulting the literature, however, it was ound to be a species of *Macrophomina*. Mr. Sunderraman of Coimbatore lately ıttributes a disease of cotton on that side o *Macrophomina phaseoli*. Whether these both are identical remains yet to be seen. Perhaps it may be a different species altogether or a physiological form. The causal ıgent was so long known erroneously under he name of *Rhizoctonia bataticola* which ıame is now replaced by *Macrophomina* sp. The latter nomenclature is accepted even in the Cultural List of Baarn (Holland).

V. N. LIKHITE.

Research Laboratory,
Agricultural Experimental Station,
Baroda,
July 5, 1932.

Investigations on Rice in Assam.

RICE investigations in Assam are mainly devoted to pure line selection and hybridization at the Government rice stations at Karimganj and Titabar. The classes of rice that are being dealt with are *aus* or *ahu* (summer and autumn rice), *sail* or *sali* (winter rice), and *asra* (shallow-water *aman*), which is grown only in the Surma Valley. Experiments on *aman* (deep water rice) and *boro* (spring rice) have not yet been tried.

Pure line selection.—The work on pure line selection has been continued for the last fourteen years at Karimganj and for six years at the Titabar station. There are altogether over 2,000 types isolated as pure from about 600 samples collected from different localities of Assam as well as outside. To compare high yielding varieties the "Latin Square method" is adopted in $10' \times 10'$ plots replicated in twelve to twenty-four times or more. The results are tabulated and statistical methods employed for the computation of mathematical constants to express the features of the types under comparison in comprehensible terms. As a result of successful selection, eighteen high-yielding types have up-to-date been recommended from Karimganj station and six types from the Titabar station, which are being grown in various parts of the plain districts of Assam with more or less success in one locality or the other.

Hybridization.—The work on hybridization is being continued for the last eleven years at Karimganj and five years at Titabar station. The characters of rice have been studied in detail in reference to the following :—

(1) Colour character in different parts of the rice plant such as leaf-sheath, pulvinus,

ligule, auricle, internode, outer glume, inner glume, tip, stigma and kernel.

(2) Vegetative character—

(a) Awn (long *vs.* short).

(b) Outer glume (long *vs.* short).

(c) Size and shape of unhusked grains (large *vs.* small and long *vs.* short).

(d) Glutinous endosperm (glutinous *vs.* non-glutinous).

(e) Panicle (dense *vs.* lax and long *vs.* short).

(f) Clustering of spikelets (single *vs.* clustering).

(g) Double kernel (single *vs.* double).

(h) Straw (tall *vs.* dwarf and strong *vs.* weak).

(i) Flowering (early *vs.* late).

Apart from the above, a few interspecific crosses have also been tried. It is with a view to study the above characters and, if possible, to combine desirable traits, apparently inherent in individual types, that a large number of crosses were made, their genetic data for successive generations studied, and "goodness of fit" calculated in each case. As a result of successful selection two hybrids, *viz.*, Karimganj$_1$ and Karimganj$_2$ have already proved successful in cultivators' field and there are four hybrids giving promising results under comparison.

S. K. MITRA.

Jorhat,
July 7, 1932.

Vibrations of Different Parts of the Piano-Forte Sound-Board.

IN my previous paper,* I described the vibrations of the Piano-forte sound-board in general and derived a certain number of conclusions from the analysis of the vibration-curves which were photographed by the electro-magnetic method described in the same paper. Now the author has studied the vibrations of different parts of the Piano-forte sound-board and brought into light the following facts :—

1. The nature of all the vibration-curves of the different parts of the Piano-forte sound-board, for the same key of the key-board, is the same but their amplitude varies.

2. That the greater the length of the rib, the greater is the amplitude of the fundamental vibration of the rib.

3. That the harmonics which are prominent in one curve are also prominent in the others, *i.e.*, the vibrations of all the ribs are exactly similar.

4. That when the ribs of smaller length are set into vibration, they do not produce higher harmonics of prominent amplitude and thus the higher harmonics become less and less prominent in vibrations of the points lying on the smaller ribs.

5. That the greater the length of the rib, the greater is the amplitude of the harmonics. Hence to produce more harmonics of higher pitch the ribs of larger length are used. That is why, in order to increase the length of the ribs for a certain sounding-board, the ribs are attached to the sound-board diagonally and not vertically or parallel to the foot of the Piano-forte.

6. That all the ribs are vibrating with the same frequency, and the maxima which are present in the vibration of one curve are the same in the case of others. Hence the sound-board vibrates as a whole in one piece round the ribs though it consists of good many pieces of seasoned wood attached to one another and though the ribs divide the sound-board into different fields.

In addition to arriving at the above conclusions the previous method of photographing the vibrations of the sound-board, is also improved a little. The details of the above will soon appear in the *Indian Journal of Physics*.

L. D. MAHAJAN.

Physics Laboratory,
Mohindra College, Patiala (India),
July 4, 1932.

* L. D. Mahajan, "Vibrations of the Piano-forte Sound-board," *Indian Journal of Physics*, **4**, 515.

Relation Between Charge and Viscosity of Colloidal Solutions.

THE results of viscosity measurements of colloids in the presence of electrolytes are generally explained on the basis that viscosity is related to the charge on the

colloid and that smaller the charge on the colloid greater will be its viscosity. The results of the viscosity measurements of colloids with the progress of dialysis are also explained on the basis of the same view. Very few simultaneous measurements of charge and viscosity have, however, been carried out to test the validity of this view. In our laboratory we are making simultaneous measurements of charge and viscosity of various colloidal solutions, dialysed to different extents, in the presence and absence of electrolytes. The purpose of this note is to give a summary of the results of some measurements made by Mr. A. K. Desai in our laboratory on colloidal thorium hydroxide with the progress of dialysis (freeing the colloidal solution from hydrochloric acid and thorium chloride introduced during peptisation).

The charge has been measured by Mukherjee's improved method. The dialysate with suitable additions of hydrochloric acid was found to be very convenient as an upper liquid for charge measurements ; the difference between direct and reverse readings generally never exceeded 5 per cent. Thorium hydroxide being a colourless sol, the movement of the boundary was followed with the help of a parallel beam of light. The viscosity was measured with an ordinary Ostwald viscometer.

The results show that with the progress of dialysis although the charge on colloidal thorium hydroxide first increases and then decreases, the viscosity continuously increases. This would mean that charge and viscosity are not related with each other upto a certain stage of dialysis of the sol.

With the progress of dialysis, as the sol is freed more and more from the electrolytes, initially present, one would expect a continuous decrease in the viscosity, the decrease in viscosity being more marked in the beginning than in the later stages of dialysis. The electro-viscous effect will produce a continuous decrease in the viscosity during the period when the charge on the colloid increases with the progress of dialysis. Both these effects, *viz.*, decrease in the electrolyte content and intital increase in the charge with the progress of dialysis, should have decreased the viscosity in the intitial stages of dialysis rather than increase it as in the measurements discussed here. The water content of the colloid particles considerably affects the viscosity of sols, particularly of the lyophillic sols. It is well known that sols like ceric hydroxide which are not markedly electrocratic set *en bloc* to a gel in the dialyser when subjected to extreme dialysis, even without addition of electrolytes and this is mainly due to the fact that the water content or the hydration of particles increases with the progress of dialysis. Hydration will increase the "active volume" and therefore viscosity will continuously increase with the progress of dialysis even in the initial stages of dialysis. An initial increase in viscosity with the progress of dialysis will also occur in the case of thorium hydroxide which resembles ferric hydroxide and aluminium hydroxide which are closer to the hydrophillic sols as regards their viscosity. Our experiments with electrocratic sols—gold sol and others—are expected to elucidate further the nature of this hydration effect. There are yet other effects, *viz.*, the shape and structure of the particles which may vary with the progress of dialysis and may also to a certain extent be responsible for an initial increase in viscosity in spite of an increase of charge. As for the variation in the shape of the particles of thorium hydroxide when it is subjected to dialysis very little is known. The structure of the particles seems to be changing on dialysing in the case of colloidal thorium hydroxide as the sol becomes more and more opalescent with the progress of dialysis. The increase in the opalescence during dialysis is probably due to an aggregation of colloid particles and this aggregation will increase the viscosity as during coagulation.

It will be seen from the foregoing considerations that it is not safe to draw conclusions about the charge on colloid particles with the help of viscosity and such other data, *e.g.*, flocculation values which show a similar behaviour—continuous decrease in the flocculation values of thorium hydroxide with KCl when the colloid is

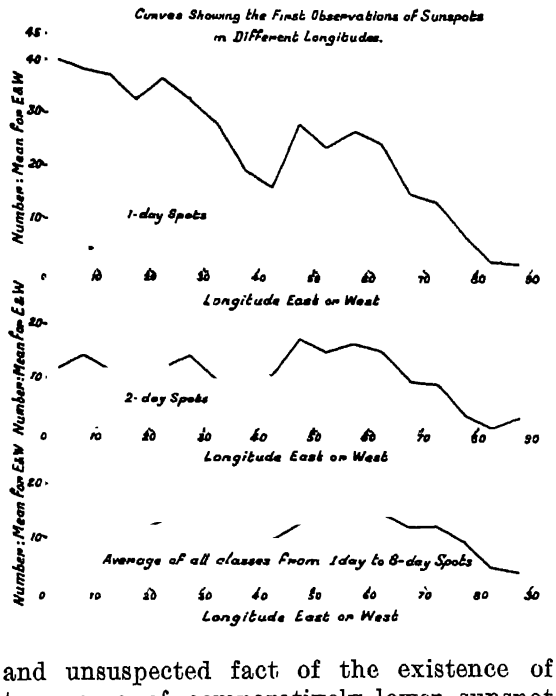
subjected to dialysis, although in some cases they may afford a correct criterion for the same.

B. N. DESAI.

Physical Chemistry Laboratory,
Wilson College, Bombay 7,
July 22, 1932.

Two Longitudinal Zones of Apparent Inhibition of Sunspots on the Solar Disc.

THE nature of the distribution of sunspots in latitude is well known, but no one has hitherto examined their distribution in longitude. This is obviously due to the expectation that there would be no peculiarity in such distribution on a rotating globe like the sun, where sunspots have equal chances of occurring in all longitudes. I had, however, the curiosity to analyse the Kodaikanal records of 20 years from 1909 to 1928, with a view to examining the first occurrence of sunspots of different durations in the different longitudes of the sun. The investigation has revealed the remarkable



and unsuspected fact of the existence of two zones of comparatively lower sunspot frequency between 30° and 50° of longitude east and west of the sun's central meridian. Confirmation of the result has also bee obtained by an examination of the Green wich Photohelio Results which cover larger number of years. The accompany ing curves show the positions of the zone between the sun's central meridan and th limb as revealed by the Kodaikanal Record It is significant that these two zones occup a permanent position with respect to th central meridian whose position on the su is, as is obvious, relative to that of th earth. The details of the investigation wi appear in a bulletin of the Kodiakan Observatory.

P. R. CHIDAMBARA IYER.

Kodaikanal Observatory,
July 22, 1932.

Further Notes on Ariyalur Fossils.

THE mammalian fossils recently obtaine from Ariyalur very strongly resemble an possibly most of them are identical wit the Upper Siwalik fauna which belong t the Pliocene Age. The occurrence in th neighbourhood of Trichinopoly of teet vertebræ and limb bones of Hyæna, Bo Sus, Rhinoceros, Equus and portions c antlers of Cervus and Bucapra included i our collection will materially support th view, we venture to put forward for th first time that portions of Cuddalore rock overlying the cretaceous deposits of Penin sular India, must belong to Pliocene system homotaxial with the Upper Siwaliks. Ou future investigations will be devoted t collect more evidence in favour of the thesi we propound here. It is well known tha at about the time when the fauna of Siwalil province attained its greatest profusion a general movement of the various familie commenced which culminated in a genera migration towards the south at about th close of the Pleistocene times. The evi dence derived from certain faunistic pecu liarities of the hills and mountains of Sout India points to this conclusion and when towards the close of the Tertiary age th Siwalik fauna was destroyed by the glacia climate, dampness of atmosphere, especiall in the plains of India, some of the migrant to the south might have secured a habita

less affected by atmospheric changes and possibly survived the general cataclysms which overtook their northern congeners.

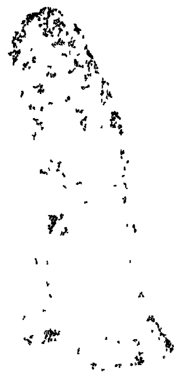


Plate I.
Horn showing bur of a deer.

Plate II.
Cervical Vertebra of a Ruminant, possibility of Bos.

We hope to be able to revert to the subject soon with more evidence than we are able to put forward at present and reproduce here photographs of two fossils from our collection which is fairly rich. These are proposed to be dealt with in detail separately.

B. R. SESHACHAR.
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L. S. RAMASWAMI.

University of Mysore,
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Bangalore,
July, 1932.

Occurrence of the Tracheids in the Gametophyte of *Adiantum lunulatum* Burm.

LANG has described tracheids in the apogamous gametophytes of a few species of ferns.* So far as the knowledge of the writer goes, nobody else has described the presence of tracheids in the fern gametophyte. The writer has come across stray patches of tracheids in the body of the gametophyte of the fern *Adiantum lunulatum* Burm. Pure cultures of the gametophyte of the species were raised from the spores, which were sent by Ratna Bahadur Pradhan from Sikkim. The spores were sown on sterilized soil in pots which were covered over with glass plates to avoid contamination. The cultures were placed in a glass house with cultures of other species, all of which were watered from below.

The well-developed prothalli of *Adiantum lunulatum* show tracheids in the region just anterior to the cushion behind the apical notch. The cells at this place are very much elongated even if they are not thickened in the manner of the tracheids. The latter usually form clusters of 2—4 elements. In the prothalli which have either developed two anterior growing points or where the normal growing point has become shifted to one side, another patch of tracheids may develop in the tissue posterior to the growing region. Two or sometimes three groups of tracheids which remain usually isolated from one another have been observed in a single prothallus.

The antheridia of the species are of the

* *Phil. Trans.*, **190,** 1898.

usual leptosporangiate type and produce apparently functional motile sperms. The archegonia, however, are completely absent and have not been seen. The sporophyte arises apogamously as a bud from the gametophyte. The tracheidal mass formed in the interior of the apogamous bud may be connected with the tracheids of the prothallus but more often it remains quite isolated.

The gametophytes of *Pteris biaurita* Linn. and *Anisogonium esculentum* Presl. kept alongside the cultures of *A. lunulatum* showed no development of tracheids. The former resembles *A. lunulatum* in the complete absence of archegonia and the development of embryo by means of an apogamous bud. *Anisogonium esculentum*, however, has a normal prothallus.

It seems that the development of tracheids in the gametophyte of *Adiantum lunulatum* is not due to the effect of external conditions but depends probably on internal causes. Further cultural and cytological investigations are in progress.

P. N. MEHRA.

Lahore,
July 11, 1932.

A Short Note on the Structure and Development of *Petalophyllum indicum* Kash.

THE species was found for the first time by the writer in November 1925 and a brief systematic description was given by Prof. Kashyap in the *Journal of the Indian Botanical Society*.* The writer has worked out pretty fully the structure and development of the plant with the exception of earlier stages of the sporophyte. The midrib of the thallus is mycorhizous, the cells containing unseptate hyphæ. Enlargements of the hyphæ resembling oogonia have also been found in certain cells. Growth takes place by means of a three-sided pyramidal apical cell giving off two lateral and one ventral series of segments. The growing point is protected by 3-5-celled mucilage hairs and a few triangular scales.

The plants are diœcious. The scales which protect the antheridia become occasionally fused near the apex to form definite chambers in which the antheridia lie. The development conforms to the usual type of the Jungermaniales. A row of three cells is formed before the formation of a vertical wall. In one case a row of four cells was present without any vertical wall whatsoever.

The development of archegonium follows the usual Jungermaniales type. A few abnormal archegonia have been seen ; in one case there were two eggs in the venter, in another the ventral canal cells were multinucleate. A careful investigation of the perianth proves it to be similar to the perianth of *Sewardiella tuberifera* described by Prof. Kashyap.* In the course of its development, there are free bracts in the early stages which are carried up by basal zonal growth to form the usual bell-shaped perianth. A few bracts are found attached to the inner and the outer surface of the perianth and a few are sometimes met with quite free inside the involucre near the base of the seta.

B. R. VASISHT.

Lahore,
July 11, 1932.

* *Jour. of the Ind. Bot. Soc.*, **6**, 14, 1918.

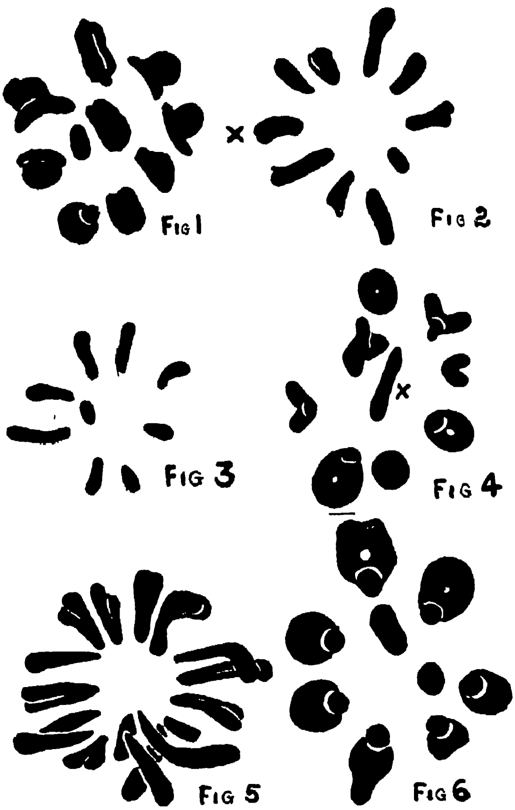
* *New Phytologist*, **14**, 1915.

Chromosome Number in Pyrgomorphinæ (Acrididæ).

THE chromosome number in the males of the majority of Acrididæ (Acridinæ, Oedipodinæ and Tryxalinæ) has been established to be 23 including 11 euchromosomes and a single X-chromosome. A few occasional variations occur but are of a nature not to invalidate the numerical constancy in the group. But in the subfamily Pyrgomorphinæ, as alluded to by McClung casually in a foot-note to his paper on the Synopsis of Mecostethus,† the chromosome numbers exhibit definite departure from the above rule. The writer has been engaged for some time past on a comprehensive study of the chromosome behaviour in the male germ cells of Pyrgomorphinæ and preliminary to the preparation

† *Jour. Morph.*, **43**, 2, 1927.

of a detailed account he desires to record in these columns the chromosome numbers of three genera of the group.



Colemania spheneroides Bol. exhibits 19 telomitic rod-shaped chromosomes in the spermatogonial complex showing a gradual seriation in size. During the first spermatocyte metaphase they resolve themselves into 9 ring-shaped tetrads and the X-element (Fig. 1). Fig 2 shows one group of second spermatocyte metaphase containing the X-chromosome. In *Aularches miliares Linn.* and *Chrotogonus* sp., however, the diploid number is 17—all telomitic. While in *Aularches* the first spermatocyte contains 8 ringed terads and the X-element (Fig. 6), in *Chrotogonus* there are five rings and 3 V-shaped tetrads beside the X-element (Fig. 4). Fig. 3 is a second spermatocyte metaphase plate of *Chrotogonus* and Fig. 5 the spermatogonial metaphase plate of *Aularches*. Similar studies of a number of other Pyrgomorphines are in progress.

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July 29, 1932.

The First Spark Spectrum of Arsenic.

IN a recent communication by the writer,* the chief triplet and singlet terms of AsII, due to the configurations $4s^24p^2$, $4p5s$ and the ^3D and ^1D terms of $4p\,4d$, were identified and reported. With a view to extend the analysis into the visible and the near infra-red regions, the spectrum of the discharge through pure arsenic vapour, contained in capillary tubes, has been photographed with a glass littrow spectrograph, using varying intensities of discharge. With our knowledge of the intervals of the $5s^3P$ terms ($5s^3P_1-5s^3P_2=2380$ cm^{-1} and $5s^3P_0-5s^3P_1=397$ cm^{-1}) and with the aid of these recent experiments it has been possible to establish the chief triplet terms due to the $4p\,5p$ configuration. These are shown in Table below.

There are still some strong and diffuse groups of lines in the visible and the quartz regions which have to be ascribed to the singly-ionised atom of arsenic. It was suggested in the previous paper that these diffuse groups of lines might be due to the transition $4d \rightarrow 4f$, of the series electron, giving rise to multiplets of the type $^3D^3F$, $^3F^3G$, $^3D^3D$, etc. Since the previous work was completed, the $4d^3F$ and the $4d^3P$ terms have been identified. A knowledge of the intervals of the $4d^3D$ and the $4d^3F$ terms has led to the assignment of these groups of lines as being due to the combinations $4d^3D-4f^3F$, $4d^3D-4f^3D$ and $4d^3F-4f^3G$. Besides these, the ^3P and the ^3D terms due to the configuration $4s\,4p^3$ have been discovered. The $4p^3\,{}^3D$ terms are found to give strong combinations with the $5p^3D$ and the $5p^3P$ terms.

The hyperfine structure of some of the important lines between 6000A and 4000A

Proc. Phys. Soc., 44, 243, 343.

	$5p\ ^3D_1$ 65876	$5p\ ^3D_2$ 65676	$5p\ ^3D_3$ 63592	$5p\ ^3P_0$ 64553	$5p\ ^3P_1$ 63610	$5p\ ^3P_2$ 62530
		200.2	2083.6		942.5	1079.6
$5s\ ^3P_0$ 84059	18183.4 (10)				20449.4 (8)	
397						
$^3P_1$ 83662	17786.0 (5)	17986.0 (10)		19109.6 (8)	20052.1 (9)	21131.7 (10)
2381						
$^3P_2$ 81281	15406.0 (4)	15606.2 (4)	17689.3 (10)		17671.6 (8)	18751.3 (10)
$5s\ ^1P_1$ 79972					16360.3 (10)	17441.2 (6)

has been studied using Lummer plates and etalons. Although it is found that the classification of the lines given by Tolonsky is not correct, the value of 3/2 for the nuclear spin moment is confirmed (Tolonsky, *Nature*, **129**, No. 3261, 652).

Details of the work will be published elsewhere.

A. S. RAO.

Solar Physics Observatory,
Kodaikanal,
July 22, 1932.

Research Notes.

Adsorption of Gases.

AT the general discussion on adsorption of gases held by the Faraday Society, emphasis was laid on two types of adsorption, activated adsorption and adsorption of the Van der Waals type. Activitated adsorption or "Chemi-adsorption" takes place at high temperatures and the heat associated with it is roughly ten times that developed during the Van der Waals type adsorption which is a low temperature phenomenon.

The importance of the work of Volmer and his school on the mobility of adsorbed molecules, the promising use of thermionics in adsorption problems, the discontinuous nature of adsorption curves were other features brought out during the discussion. Special mention may also be made of the theory of Lennard Jones which satisfactorily explains a number of adsorption phenomena.

Disintegration of Elements.

COOKCROFT and Walton have recently described their experiments (*P.R.S.*, **137,** 229, 1932) showing that protons of energy over 150,000 volts are capable of disintegrating many elements.

Positive ions from a hyrdogen canal ray tube, falling through voltages upto 600 kilovolts, hit a target of the element to be investigated. The source of error due to the emission of the secondary electrons, which have energies below 20 volts, is eliminated by applying a magnetic field of about 700 gauss to the target. The secondary radiation for Lithium is shown to consist of particles with a range of about 8 cms. This range does not alter by varying the accelerating voltage between 250 and 500 kilovolts. By the use of the Shimizu expansion chamber and Williams-Ward ionization-chamber method, these particles have been identified as α-particles, produced by the disintegration of Li_7, into two α-particles under proton bombardment :

$$Li_7 + H_1 = 2He_4$$

The decrease of mass in the disintegration corresponds to an energy liberation of $(14.3 \pm 2.7) \times 10^6$ volts, which is in agreement with the observed energies of the α-particles. The probability of the proton penetrating a lithium nucleus according to Gamow's theory (*Zs. f. Phys.*, **52**, 510, 1928) is higher than their observed value. The authors are attempting to improve their experimental technique.

Lithium, Boron and Fluorine yield the largest emission of α-particles and they are all of the $(4n+3)$ type containing perhaps nuclei of α-particles with the addition of three protons and two electrons. Certain other elements have been disintegrated and the results will be clear from the following reactions:—

$$Na_{23} + H_1 = Ne_{20} + He_4$$
$$K_{39} + H_1 = A_{36} + He_4$$

The Relation of the Duodenal Mucosa to the Internal Secretion of the Pancreas.

LAUGHTON and Macallum (*P.R.S.*, Ser. B., **3**, No. 769, 1932) have succeeded in the separation of an active principle from the duodenal mucosa of rabbits, dogs, hogs and cattle which in its physiological properties differs from secretin and insulin. In the experiments conducted by them, they establish that this new substance has no effect on the external secretion of pancreas, but has a hypoglycæmic effect different, however, from insulin. It has practically no effect on the blood sugar when injected into the totally depancreatised dog, but manifests a decided influence in reducing the sugar of a partially depancreatised dog in which hypoglycæmia is experimentally induced, causing the blood to return rapidly to the normal level. It has no hypoglycæmic effect, like insulin in normal animals. It is assumed that this preparation stimulates the islets of Langerhans to secrete insulin. The paper discusses the probability that this substance is in the nature of an insular harmone whose physiological effect on the internal secretion of pancreas takes us a step forward in the control and treatment of diabetes mellitus.

The Absolute Measurement of High Electrical Pressures.

IN a paper in the *Journal of the Inst. of Electrical Engineers*, Prof. W. M. Thornton and W. G. Thompson describe a method in which the polarization of a metallic Ellipsoid of Revolution, suspended by an insulating fibre between vertical circular pole plates is used to measure high electrical voltages up to 200,000 volts. The measurements of voltages by this method have been compared with sphere gap determination of voltage. Continuous measurements of voltages upto 200,000 volts can be made with the precautions indicated in the paper to an accuracy of at least 3 parts in 1,000.

Absorption of Water by Root System of Plants.

[Paul J. Kramer. *Amer. Jour. Bot.*, **39**, 148, 1932.]

FROM earliest days of Plant Physiology, workers have taxed their ingenuity to explain the absorption of water and of root pressure in Plants. The various theories put forth from 1832 to 1930 bearing on the problem vary widely in the importance attached to activity of the living cells of the root. However, they fall under two lines, either the living cells of the roots play the important part, or the physical forces concerned operate independent of the living cells. The experiments conducted and described by the author throw further light on the actual rôle of the living cells of the roots. Under conditions of reduced transpiration the water absorbed moves from the soil to the conducting vessels by osmosis across the differentially permeable multicellular membrane—the living cortex of the root—and accumulation of the water in the vessel developing a positive root pressure. Such positive pressures were manifested at the cut ends of stems, only when the roots were alive. Tips of plants with dead root system, remained alive for several days. Plants with root systems killed and suction applied at the cut end of the stem absorbed water for a few days as though the root system was alive. The rôle of the living cells of the roots in such

absorption processes is apparently a passive one. They are important as absorbing surfaces in preventing the entry of air into the vessels, and in extending the area of absorption by growth.

The Gondwana System.

THE recent memoir (Vol. LVIII) by Dr. C. S. Fox on "The Gondwana System and related formations" forms one of a series of four memoirs dealing with "Coal in India" proposed to be published by the Geological Survey of India. The present memoir is a summary of all the available information on the Gondwana system, brought up-to-date as far as possible, so as to include the results of the most recent work on some aspects of this subject by eminent palæontologists like Dr. Cowper Reed and Prof. A. C. Seward. There is a thorough discussion of the problem of the classification of the Gondwana system, and a revised classification, which may be considered satisfactory in the present state of our knowledge, is suggested in a tabular form (Plate 9) accompanying the memoir. The author has also referred to the palæo-geography and climate of the Gondwana land, and has endeavoured to depict the changes in the distribution of land and water in India during the Gondwana era by a series of four maps. The author is of opinion that considering the great lapse of time—150 million years—the geographical changes during the Gondwana era are remarkably small and that the general distribution of land and sea, according to present-day conceptions, was relatively constant throughout the period.

Neutrons in the Atmosphere.

IN a letter to *Nature* (**130,** 57, 1932) Moon, in an attempt at evaluating the neutronic concentration in the atmosphere shows that the presence of neutrons brings about an *apparent* decrease of the Newtonian gravitational constant with increase of temperature. Combining the experimental results of Shaw (*Phil. Trans.*, **216,** 349, 1916) with his own approximate formula for the partial pressure of neutrons in the atmosphere, he finds that with the neutronic data available at present the partial pressure is of the order of 10^{-6} atm.

Periodic Failures and the Punjab American Cotton Crop.

IN some years the Punjab American Cotton Crop has been afflicted with an unknown disease, the damage caused by which exceeded 5 million pounds sterling. It was fairly general over the Punjab Province in 1919, 1921, 1926, 1927 and 1928. Roger Thomas ("Periodic Failures of the Punjab American Cotton Crop," *Agriculture and Live Stock in India,* Vol. 2, Part 3, May 1932) from his investigations is of the opinion that the basic cause of these crop-failures in the Punjab is the cotton white fly (*Bamisa gossypiperda*).

The paper describes the distribution and life history of this pest. Comparisons of the damage done by this pest in cage experiments and the symptoms of the disease are outlined. The intensity of the white fly in any year is believed to be largely controlled by rainfall during the months of May to August and also by predators and parasites.

This explanation of the cause of the failure of cotton crop is not generally accepted by cotton research workers in India or by the Punjab Agricultural Department.

The author describes economic and practical methods of controlling the white fly, which he has applied on a commercial scale in the plantations of the British Cotton Growing Association. The method includes: (*a*) spraying the crop during the months of July and August with rosin-soda compound, (*b*) manuring the crop at flowering stage (end of August or early September) with a light dose of nitrogenous manure, (*c*) delay the sowing until late in May or early in June, and (*d*) breeding strains relatively immune to white fly attack.

Laboratory Lightning Doubled in Voltage.

(*Electrical World, June* 18, 1932.)

AT the Pittsfield Works Laboratory of the General Electric Company 10,000,000 volts

have been artificially produced by the Lightning generator designed by Mr. F. W. Peek, Jr. This lightning forms a 60 ft. arc and has a capacity of 50,000,000 KW. discharged in one microsecond across a sphere gap. The maximum current delivered during discharge after the resistance of the air has been broken down is 50,000 Amps.

In 1929 artificial lightning discharges of 5,000,000 volts were attained at Pittsfield. Similarly 1,000,000 volt, 60 cycle, 3 phase arcs were produced.

Locomotor Organs of Echinarechinus parma.

[Parker George H. and Margaret Van Alstyne. *Biol. Bull.*, **62**, 195, 1932.]

THE method of locomotion in Echinarechinus Parma is described for the first time. Of the three classes of organs, integumentary cilia, tube-feet and spines suspected of having to do with locomotion, integumentary cilia do not play any significant part in the process as they cover only the tips of the short spines and the sides of the long ones. The tube feet which are provided with suckers are important in locomotion only to a limited extent in that they pile up sand on the aboral surface. Spines, which are of two types, short and long, are best developed over the anterior portion of the oral surface. Waves of co-ordinated spine movement enable the animal in forward locomotion, burrowing and righting.

Radiations Excited by α-Rays in Light Bodies.

IN *Comptes Rendus*, **194**, 2208, 1932, Mme Irene Curie, M. F. Joliot and M. P. Savel describe experiments in which beryllium and lithium were bombarded with α-rays and the properties of the emitted neutrons were studied. This was accomplished by making the neutrons pass through paraffin and determining the range of the H-rays produced. When the neutrons were emitted forwards, *i.e.*, in the direction of the incident α-rays two different groups of H-rays were observed, having respectively the ranges 43 and 110 mg./cm.^{2} of Al which correspond to 28 and 70 cm. in air. The more penetrating H-rays were not observed when paraffin was replaced by carbon. From the presence of the two groups of H-rays, the authors infer the production of two groups of neutrons having the velocities 2.94×10^9 and 3.84×10^9 cm/-sec. *i.e.*, having energy equal to 4.52×10^6 and 7.8×10^6 eV respectively. These results are represented by the reactions:

$$Be_9 + \alpha \rightarrow C_{12} + n \uparrow + \gamma$$

$$\text{and } Be_9 + \alpha \rightarrow C_{12} + n \uparrow$$

In the first case the neutrons had a small velocity but at the same time secondary rays corresponding to γrays of energy between 2 and 4.5×10^6 eV were observed. Hence the conclusion that the liberated energy gives rise to neutrons of large velocity in the second case and to neutrons of smaller velocity together with γ-rays in the first case.

When the neutrons are shot backwards *i.e.*, at angles of 120° to 180° with the direction of the incident α-rays, two groups of H-rays of ranges 26–32 and 7–10 cm. are to be expected, but only one group having a range lying between these limits was observed. The range was 35 mg./cm.^{2} of Al which corresponds to 23 cm. of air. This result is explained by the authors as possibly due to the low accuracy of the measurements in this case. They also think that the presence of a group having the maximum range 40 cm. as found by Chadwick (who obtained two groups corresponding to 22 and 40 cm. whether the neutrons were shot forward or backward) is doubtful in view of the proton absorption curves obtained by the present investigators.

Assuming the above reactions and taking the mass of the neutron as 1.006 (a value deduced from the reaction, $B_{11} + \alpha \rightarrow N_{14} + n \uparrow$ assuming He=4) the mass of Be_9 has been found to be 9.006. From this they conclude that the energy of binding of the α-particles and neutron forming the Be_9 nucleus is very small.

Anatomy and Micro-Chemistry of the Cotton Seed.

[R. G. Reeves and C. C. Valle. *Bot. Gaz.*, **93**, 259, 1932.]

THE Cotton seed once regarded as worthless has taken a prominent place among the agricultural commodities, since the recognition of the uses of cotton seed products. The previous investigators disagree as to the localization of certain chemicals and oils in the seeds, the extraction of which presents various types of problems. The present work was undertaken to get accurate knowledge of some of the debatable problems pertaining to the subject. Young ovules and mature ovules of American upland cotton were studied in addition to Pima and Sea Island cottons. The anatomy of the ovules, layer by layer, has been described and illustrated with sketches. The embryos, both young and old, are found to contain traces of starch in addition to oil. The commonly noticed pentosans occur in the resin glands which contain other substances also. At maturity endosperm cells contain small quantities of starch and an abundance of protein and oil; the perisperm is referred to by Winton as the remaining epidermis of the nucellus. The integuments are free from starch before maturity. The pigmentation of the cells of the palisade and epidermal layers is associated with a hardening protoplasm. The palisade layer is part of the inner integument and contains cellulose and lignocellulose.

Urease Content of Leguminous Seeds.

SOYA bean and Jack bean have been extensively employed as sources of urease, but the possibility of the existence of richer sources of the enzyme has not so far been explored. With this object in view, Sundara Iyengar and Sastri have examined more than thirty commonly occuring leguminous seeds belonging to different suborders and have arrived at certain interesting conclusions. Among the seeds examined, *Pongamia glabra* showed the highest urease activity; *Dolichos biflorus* and *Cajanus indicus* came next. Narayana Menon and Narayana Rao (*Ind. J. Med. Res.*, **19**, 1077, 1932) have, independently of this work, shown that *Dolichos biflorus* is as rich a source of the enzyme as Soya bean. *Pongamia glabra* thus constitutes one of the richest sources of urease.

Twinning in Plagioclase Felspars.

THE two papers on the application of Federov methods for the study of the twinning of Plagioclase Felspars, recently published by A. L. Coulson (*Rec. Geo. Sur. Ind.*, 65, Pt. 1) are of considerable interest. In the first paper dealing with the zoning and difference in composition of twinned Plagioclase Felspars in certain rocks from Sirohi State, Rajputana, ten instances of the difference in composition of the individuals of twinned Plagioclase Felspars have been described, and it has been pointed out that "the difference in composition between individuals forming a twinning combination is not always evidenced by zoning and this leads one to doubt determinations of composition based solely on observations of the zone perpendicular to the twinning plane." In the second paper dealing with the Albite-Ala B twinning of Plagioclase Felspars in certain acidic rocks from the same area, the author points out, that out of ten twinning combinations measured in the Plagioclase phenocrysts of dellenites and porphyries from one locality, six contained the Albite-Ala B complex; and all the Albite-Ala B complexes had a composition of about 33 per cent An.—which composition appears to be peculiarly favourable for the formation of this complex.

The Structure of Vertebraria.

Vertebraria, like *Glossopteris*, is one of the commonest and most characteristic plant-fossils of the Lower Gondwana (Upper Carboniferous and Permian) rocks of India and the Southern hemisphere. But its structure and affinities have long been a problem. Originally regarded as one of the Equisetales, it was later suspected to be the stem of a fern. The latter view was influenced by the discovery of specimens bearing leaves of the *Glossopteris* type, which were then believed to be fern fronds. More recently the view has gained ground that *Glossopteris*,

and therefore *Vertebraria*, belong to seed-bearing plants. Prof. Walton of Glasgow and Miss J. R. Wilson have recently thrown some light on the structure of *Vertebraria* (*Proc. Roy. Soc. Edin.*, **52** (ii), 8, 200, 1932). With the help of Walton's cellulose peel method it has been shown that the greater part of the axis consisted of secondary wood of the gymnospermous type. The tracheids are provided with multiseriate bordered pits, which may be either opposite or alternate ; the medullary rays are narrow, and in the area common to a medullary ray cell and a tracheid several bordered pits are present. The primary wood and pith (if one was present) appear to have been very poorly developed. In specimens preserved at right angles to the planes of bedding the thin plates of tissue radiating from the centre represent the much-compressed wedges of secondary wood. In the living plant these wedges must have nearly filled the large triangular spaces between them, leaving room only for the medullary rays. The present work thus supports the view that *Vertebraria* belongs to a seed-plant.

A Fossil Dicotyledonous Wood, Devoid of Vessels, from the Rajmahal Hills.

Sahni describes under the name *Homoxylon rajmahalense* gen. et sp. nov. (*Mem. Geol. Surv. Ind., Palæont. Indica, N.S.* **20** (2), 1, 1932) what is no doubt an angiosperm wood of an archaic type. It resembles *Drimys*, *Trochodendron* and other members of the primitive Ranalean plexus in the absence of true vessels, the pitting of the tracheids, the structure of the medullary rays and in other features. The age of the fossil is believed to be Jurassic, but is not known with certainty.

A Comparative Study of the Phosphagens with some Remarks on the Origin of Vertebrates.

[O. M. Needham, J. Needham, E. Baldwin and J. Yudkin, *P.R.S.*, Ser. B. **110**, No. 767, 1932.]

SUBSEQUENT to the discovery of labile phosphorus in muscular tissue by Eggleton and Eggleton (1927), it has been practically assumed that arginine phosphate is characteristic of invertebrates while creatine phosphate is characteristic of *Cephalochorda* and *Vertebrates*. The usual Fiske and Subbason (1929) method with the various modifications thereon have been followed. Practically examples of every group have been experimented upon and it should be noted, however, that *Balanoglossus* and *Echinoderma* contain both the kinds of phosphates, thus affirming Bateson's (1886) view of the affinity between *Echinoderma* and Chordata. Curiously the *Ctenophora* alone exhibit the presence of arginine phosphate in the phylum *Cœlenterata*. Further evidences are put forward to show that the arginine phosphate may be somehow associated with the ciliary movement.

The Industrial Outlook.

Tea Fermentation.

THE essential characteristics of black tea are developed during the fermentation process. The exact nature of the chemical changes involved or even the agency responsible for fermentation is still obscure and until scientific research clarifies the situation, rigid control of the process cannot be hoped for or replace the existing arbitrary standards based on visual and sensory judgments.

A certain degree of insight has, however, been obtained by the work done in several countries. Thus it is known that fermenting leaf requires oxygen, indicating that some component of the leaf is oxidised. The absorption is rapid at first but gradually slows down and the time-oxygen consumption curve is similar to curves representing enzyme action. At the same time carbon dioxide is evolved but the course of respiration is not normal. The free tannin content of the leaf decreases as also the total soluble constituents and starch. Nitrogenous compounds do not appear to take part during the fermentation. Tea tannin is capable of forming red derivatives called phlobaphenes

and these substances which are soluble in aqueous solutions of tanninsimpart the red coppery colour to tea decoctions. Prolonged oxidation leads to the formation of brown oxidation products which make the liquors dull. Aroma is developed during fermentation and this has been traced to the release of an essential oil which, on fractionation, yields an alcohol containing 6 carbon atoms and methyl salicylate. This oil is found exclusively in the leaves. Prolonged fermentation leads to a loss in flavour and Mann in 1907 suggested that this was due to the development of micro-organisms. As a result of the chemical changes, heat is developed during the fermentation and the temperature of the fermenting leaf increases in the early stages but gradually slows off.

There are at least two theories which have been put forward from time to time to elucidate the nature of the causal agency of the fermentation. The earliest was that fermentation was a putrefactive change but this had to be given up when it was shown that oxygen was essential for fermentation. The observation that fermentation was arrested at elevated temperatures—say at about 212° F.—showed that the fermentation was caused by thermolabile agents. The micro-organic theory was put forward by Kozai in 1891 and this was rigorously put to the test by Bosscha and Bozeskowsky who showed in 1916 that normal fermentation did occur with sterilized leaf. The usual sign of over-fermentation—the objectionable odour—did not develop with the sterile leaf even on prolonged fermentation. It was further shown that although the presence of some yeasts did not interfere with the normal course of the process the presence of moulds and bacteria was detrimental to the quality of tea. Oxidases, peroxidases and catalase have been demonstrated in the leaf and fermentation is ascribed to the oxidase group of enzymes. Although there is a general acceptance of this theory there has as yet been no work to show that the addition of the isolated enzyme to fermenting leaf alters the rate of degree of fermentation and until this is done the enzyme theory cannot be accepted without reservation.

Proper insight into the nature of fermentation cannot be obtained by isolated laboratory experiments alone, but such work should be coupled with large-scale factory experiments. Important work is being carried out in this direction in the laboratories of the Tea Research Institute of Ceylon. Thanks to the generous grant from the Empire Marketing Board, small-scale machinery for the manufacture of tea have been provided and it is hoped that with these facilities the nature of this important process in black tea manufacture will be elucidated.

B. N. SASTRI.

New Type Storage Battery Exhibited in France.

(*Electrical World:* June 18, 1932.)

CONSISTING essentially of a centre electrode of carbon surrounded by an absorbent material saturated with zinc iodide and contained in an electrode sheet of metallic zinc, a new type of electric storage battery was announced before the French Academy of Sciences early in June. F. Boissier is the inventor. When the battery is charged, the zinc iodide breaks down into metallic zinc that is deposited on the zinc sheeting and iodine that accumulates on the carbon electrode and in the absorbent material which may be an absorbent carbon powder. The zinc iodide is reformed during the discharge. M. Boissier claims this battery to be superior to the conventional storage batteries of the lead or nickel variety. As the plates do not disintegrate, there is no acid or caustic liquid to spill, no dangerous gases or vapours are given off and continual maintenance is not necessary.

B.K.R.

4-Ton High Frequency Induction Furnace Installed in Chicago.

(*Electrical World:* June 28, 1932.)

A 4-TON Coreless Induction Furnace has been put in operation in the Chicago District, capable of melting 40 to 50 tons per day. This is double the size of any coreless

ırnace previously installed, and is disign-l to melt low carbon stainless steel scrap, erro-alloys, etc. Essentially the furnace an air transformer whose primary is a ngle layer helix of water-cooled copper ıbing and whose secondary is the metal ıarge. Power from 1250 KVA—1000 cycle ənerator induces currents to circulate in ıe outer part of the charge thereby heating ,. No electrodes are used. The charge is ;irred by the electrical forces within the ath. Metal can be melted rapidly and ·ith very little wear on the lining.

It is reported that this is probably the rst time that the problem of carrying 12,000 .mp. at 1000 cycles or more has been suc-essfully handled.

B.K.R.

Hollow Electrode Furnace reduces Ores to Steel.

BY passing finely divided ores intimately mixed with reducing materials through the hollow electrodes of an electric furnace high grade plain carbon and alloy steels may be produced. Such a furnace reported in the *Electrical World* of June 18, 1932, as a notable advance in steel making has been manufactured by the Buffalo Electric Supply Corporation, Buffalo, N.Y. This type of furnace accomplishes in a single unit the production of a refined and finished product from metalliferous ore. It is said to have an output comparable to even the highest grade electric furnace, though acting in melting, refining and alloying capacities simultaneously with its equivalent blast furnace function.

B.K.R.

Science News.

ACHARYA Sir P. C. Ray, the veteran chemist, completed his seventieth birthday this ear. The services of this savant in the cause f Chemistry in India are very well-known. He ould easily be described as the father of chemis-y in this country, and the Indian Chemical ociety, the only organization for Chemists in ndia, owes its origin and existence to the untir-ıg efforts and munificence of the Acharya. As he founder of the Bengal Chemical and Phar-ıaceutical Works, he is the pioneer of Indian hemical Industry. No less are his efforts in he cause of the afflicted and the distressed. His rganization for the relief of the flood-stricken ı Bengal, time after time, bears testimony to the ublic activities of the scientist. His work on The History of Hindu Chemistry" is the only ne of its kind. Translated into several lan-uages it represents a great contribution to this ıteresting subject. He has been responsible or the building up of a school of Chemistry in Bengal, several of whose pupils have achieved reat eminence in their fields of study.

At a public meeting of his admirers and stu-ents held in Albert Hall, Calcutta, on the 1st. Iarch 1932, it was decided to celebrate the 70th. irthday of the Acharya in a fitting manner. A committee has been constituted to issue a ommemoration volume contributed by those who know the Acharya intimately as a master or , public worker. A book of 500 pages is pro-nised next September. We await the publica-ion with keen interest.

* * *

Dr. Zia-ud-din Ahmad, M.L.A., addressing the nembers of the University Union, Bangalore, on the 19th. July discussed the limits of error n marking the examination papers, arising from causes such as the difference of perception of excellence, personal idiosyncracies of examiners, difference of standard of awarding marks adopted by them, their fatigue and their speed of valuing. He pointed out that the total deviation due to all these sources of error, when mathematically deduced, would amount 7.5 per cent in an examination in one subject, in which there are two papers of 50 marks each. He also dwelt on the theory underlying the practice of gracing up the marks of candidates failing to obtain the minimum for a pass, and as the result of statistical investigations, it is found that in case a candidate is required to obtain 33 per cent., in an examination comprising four subjects, each consisting of two papers carrying 50 marks, the true mark of the candidate may be anything between 28—38. After reviewing the other aspects of examination, such as the deviation in the average marks of any two examiners, the determination of the order of merit, and so forth, he was led to the view that the element of chance plays an important rôle even in the best conducted examinations.

All this philosophy apart, the man in the street would like to know how far the examination marks represent the true and complete picture of the normal state of the candidates' mind, its power, range and flexibility.

* * *

The annual convocation of the Dacca University took place on the 28th. July when the address was delivered by Sir C. V. Raman. He chose for the subject of his address "Science and Human Life". He complimented Dacca on her happy environments and Bengal on having as the Chancellor of her two Universities, one whose early interest had been in the field of science.

Speaking about the relations between science and human life, he suggested that a false sense of values underlay the common belief that science was justified by its power to create wealth and new comforts or conveniences for humanity. Science was equally capable of furnishing methods for the destruction of wealth and of multiplying human misery and suffering. The true justification of science lay in its success in opening out a new vision of the universe, in giving us an insight into the origin and development of human life, in fact, in its enabling man to perceive himself in his proper relation to the universe he lived in. The progress of the human race would depend on the success attained in applying the methods of science to the study and control of human activities in all their varieties. Science was creating a new religion and a new philosophy which, Sir C. V. Raman felt sure, would replace beliefs that were founded not on demonstrable truth but were merely vestiges of man's animal ancestry.

* * *

Addressing the South Indian Science Association on the 6th. August 1932, on "Calcium Physiology", Dr. C. V. Natarajan, Superintendent, Public Health Institute, Bangalore, reviewed our present state of knowledge of the subject. Serum Calcium of normal Indian students had been determined and found to have an average of 10.2 Mgms. per 100 c.c. Determinations on a large number of Medical Students of normal health had been carried out, as also among diseased patients. Slight modifications in the technique of Kramer-Tisdall method for determining calcium were suggested so as to ensure constant results. Dr. Natarajan discussed bone-formation from the Embryological and Anatomical standpoint and also the problem of calcium deposition during ossification with special reference to the work of Robinson and his collaborators, regarding the enzyme found in certain cells (the ester on which the enzyme acts having been identified by P. A. Levine *et al* to be Glucose-6-phosphate) which acts in a manner so as to deposit calcium phosphate.

He detailed the functions of Calcium :—(i) in striped and unstriped muscle contractility, (ii) in impulse conduction in nerves, (iii) its importance in diarrhœal conditions, *i.e.*, the formation of Calcium Soaps, etc., (iv) the 'ion-antagonism' between Calcium, Potassium, Sodium and Magnesium ions, (v) Calcium significance in coagulation of Blood, (vi) the effect of irradiated ergosterol and the para-thyroid apparatus in the metabolism of Calcium, (vii) the physiological variations of the element in serum, in preparturient and lactating mothers and during the menstrual cycle, and surveyed the work of various scientists on these aspects of Calcium metabolism.

The appearance of rickets and osteomalacia among Indians is thought to be attributable to unbalanced dietary of the average Indian due to several factors, chief of which is the economical one. In spite of large quantities of *pan* (betel leaves) being chewn along with calcium hydroxide no remarkable increase of calcium had been noticed nor was there much propylaxis against diseases attributed to calcium deficiency.

* * *

An Ordinary Monthly Meeting of the Asiatic Society of Bengal was held on Monday, the 1st. August, 1932, at 5-30 p.m. The following communication was made :—

S. L. Hora.—*A Marine Air-Breathing Fish, Andamia heteroptera* Bleeker.

It is a well-known fact that a number of freshwater fishes of India, such as *Saccobranchus* (Singi), *Clarias* (Magur), *Anabas* (Koi), *Opicephalus* (Saul), etc., are capable of breathing air direct from the atmosphere to supplement their normal mode of respiration through the gills. This habit of aerial respiration has been regarded as an adaptation to life in shallow, stagnant, tropical, fresh waters which are liable to dry up during hot and dry months. A few species living in muddy ponds and rivers, and a few others living on muddy tropical shores or in mangrove swamps have taken to aerial respiration. All this implies that a medium poor in oxygen has induced the habit of breathing air in fishes. In support of this view it has been said that fishes typical of larger tropical lakes and truly marine fishes have not acquired this habit.

Andamia heteroptera is a marine fish that lives on rocks in the surf line on the shores of certain islands in the Indian Ocean. It is fairly common at Port Blair in the Andamans. The fish lives on rocks kept moist by a spray from the surf line, and continually changes its position with the tide. It is never found under water except for short periods when it may be accidentally submerged by the swell of the sea. In fact, it has been found experimentally that when individuals are kept under water, however highly oxygenated it may be and prevented from access to air, they die of asphyxiation. This shows that *Andamia* is a highly specialized air-breathing fish. What impelled this marine species to take to aerial respiration is difficult to say. The water near the surf line is highly oxygenated, and therefore, lack of oxygen cannot be the cause of this adaptation on the part of *Andamia*. The knowledge of the habit of this species has raised several points of biological interest which are now under investigaion. It is expected that much further light will be thrown on the origin and evolution of the terrestrial fauna.

A.S.B.

The Late Sir Dorabji Tata.

THE death of Sir Dorabji Tata has removed from the industrial life of India a great figure second only to his illustrious father, the late Mr. J. N. Tata. After setting the affairs of his firm on a sound footing, that great pioneer had conceived three great projects for the industrial and economic development of the country and set his whole heart on them during the last years of his life. But, while he had spent large sums of money in investigations relating to these schemes, he was not destined to initiate any one of them and it fell to Sir Dorabji to carry forward the work planned by his father. This he did with such energy and singleness of purpose that within ten years of his father's death, the wilderness of Sakchi had been transformed into a busy industrial city ; the rain waters of the western ghats had been harnessed and electric power transmitted to Bombay ; and the Indian Institute of Science had started on its ambitious work i[illegible]ngalore and already sent out its [illegible] batch of students. But Sir D[illegible] was not satisfied with merely carrying [illegible]t his father's plans. After carrying to completion these big schemes, he initiated a vigorous policy of expansion and, under his guidance, his firm launched forth on a long series of industrial enterprises including two more hydro-electric schemes, an industrial bank, an insurance company, oil and cement mills and an engineering construction company. Sir Dorabji was the chairman of most of these companies and fostered them with great care during the long years of economic depression that followed the end of the great war. He sometimes looked after the interests of these companies even at great personal sacrifice. During the dark days of the Tata Iron and Steel Company he nobly stood by its side and staked his own possessions and pledged his personal credit in support of the enterprise until Government came to its aid by granting bounties.

But he was more than a mere industrialist. He was a patron of learning and was deeply interested in the promotion of literary and scientific research which he endowed liberally. Since the foundation of th Indian Institute of Science he evinced a very keen interest in its progress and the welfare of its students. Under his guidance the Tata Iron and Steel Company founded the Technological Institute at Jamshedpu for training Indians in the metallurgy o iron and steel. Both his private charitie and public benefactions were mostly extended to deserving institutions and directed t the promotion of research. He endowe a Chair of Sanskrit in the Bhandarkar Institute at Poona and gave £ 25,000 to th University of Cambridge for the equipmen of laboratories in the School of Engineering He was also very keen on the establishmen of a school of medical research in India an offered to endow it more than once, but th proposal did not materialise due to lack o support.

There were other sides to his life. Himself a cultivated man of great taste, he wa a patron of fine arts and a great collecto His "Esplanade House" in Bombay contain valuable collection of art treasures and i was his wish that it should some day find place in a public museum. He was als a patron of sports and athletics in whic he himself excelled in his young days. H was very keen on seeing Indians win a nam in the world of sport outside India an liberally supported Indian teams visitin other countries to take part in internation games.

His fame chiefly rests on his great work i the field of industrial development during th past thirty years. But the man was great than his work. He was a great gentlema perfectly upright and universally respect for his high sense of honour and strict prob ity. He rigidly kept aloof from specul tion and invariably guided his companio into the right path. He was above consider tions of caste or creed. The last gre act of his life was perhaps more chara teristic of the man than all his industri achievements. Shortly before his death h executed a trust for his entire proper amounting to about three crores of rupe to be utilized for relieving human sufferi

and promoting human welfare irrespective of caste or creed. He also set apart a sum of twenty-five lakhs for instituting research work on anæmia and allied malignant diseases, and for rewarding successful investigators in that direction.

F. N. MOWDAWALLA.

Reviews.

IN the series of the *Indian Zological Memoirs* a recent publication which forms the 4th volume of this series, deserves mention. The Memoir is on the common Apple-snail (*Pila*) and is written by Dr. Baini Prashad, Superintendent, Zoological Survey of India. A complete account of the shell and anatomy of the mollusc, illustrated with 43 figures in the text, is given in this work, and a short chapter at the end deals with the directions for practical work for the students using this Memoir. The series is proving of great use to elementary students of Zoology working on Indian animal types, and it is hoped that it will be possible to continue publishing further memoirs in this series. The present memoir, like the preceeding ones, is published by the Methodist Publishing House, Lucknow, and its price is Rs. 2.

B.N.C.

Principles of Soil Microbiology. By Selman A. Waksman. Second Edition, pp. xxviii+894 (London: Bailliere, Tindall and Cox, 1931). Price, 52-6 net.

Prof. Waksman has rendered signal service to the cause of soil microbiology by the publication of a revised and amplified second edition of his already well-known 'Principles'.

The present publication marks a definite improvement on the first edition. Some of the older chapters have been abridged and re-written; others have been newly added, incorporating the more recent work on the decomposition of organic matter and on the relation between plant-growth and micro-organisms. The already extensive bibliography has been amplified to include all the important publcations of recent years. So complete is the information provided by the new edition that it deserves to be used as a volume of reference by those engaged in research.

While bearing ample testimony to the Herculean efforts of the author, the book betrays some of the limitations inevitable to a publication of its type. Owing to the vastness and the somewhat confused nature of the literature accumulating in different directions, many of the chapters read like threaded summaries from the card-index. The above together with the somewhat indifferent style, render the book rather unpalatable for the general reader who wishes to imbibe the principles of soil microbiology from its pages. The value of the bibliography has also been somewhat marred by the mistakes in citing some of the references.

The book has been well printed on good paper and, considering its size, is remarkably free from print mistakes. The price is unfortunately rather high and would not readily commend itself to the average purse.

V.S.

The Veterinary Bulletin, 1932, Volume 2, No. 2, pp. 65—130.

This Journal, which is a monthly from January 1932, aims at being an abstracting Journal dealing with current literature, and including references to all important British and foreign scientific work relating to veterinary research, administration, public health and education. The annual subscription is £ 2, and it is published by the Imperial Bureau of Animal Health, Weybridge, Surrey, England.

The February issue of the volume is of absorbing interest and contains extracts from or summaries of over 120 articles, arranged and classified under heading like the following:—*Diseases caused by Bacteria and Fungi*, *Diseases caused by Protozoan Parasites*, *Diseases caused by Filtrable Viruses*, *Diseases caused by Metazoan Parasites, etc.* One cannot but be struck by the care

with which the extracts have been made, and the skill displayed by the Editor and staff in dealng with them.

Of special interest to workers in diseases of animal pathology in India, are the reviews on articles contributed by workers on tuberculosis, its diagnosis and control, the diagnosis of Johne's disease using a "Bowel-Washing" method, the diagnosis of streptococcic mastitis, complications in sheep arising from the feeding of prikly pear, diseases caused by piroplasms, the control of cattle-plague in Dahomey, literature relating to foot-and-mouth disease, serum sickness in rabbits, the colon bacteria occurring in the milk-supply at Pusa and findings on investigations of other items of interest.

V.K.

Lt.-Col. R. B. Seymour Sewell, I.M.S., Director of the Zoological Survey of India, has published the 2nd part of his extensive studies on Copepoda of the Indian seas in Vol. X of the *Memoirs of the Indian Museum*. The part now published is a continuation of the work published in 1929 in the same volume. The Memoir is of exceptional interest and deals with all the species of *Calanoida* found in the Indian seas. In addition to the species examined by the author, references are given to all the forms recorded from the Indian region. The work is beautifully illustrated and should make the study of this difficult group easier for future workers. The particular feature of interest of this work is the record of the presence of small glands opening on the surface through pores in the chitinous covering. These glands, which had been recorded in the case of a few forms only, are now shown to occur much more widely in the group of the *Copepoda* dealt with by the author.

B.P.

Coming Events.

South Indian Science Association, Bangalore.

CENTRAL COLLEGE, BANGALORE

19th August, 1932.
'The Technique of Talkies', by Dr. L. C. Verman, M.A., Ph.D.

22nd August, 1932.
'Vegetable Ghee', by Mr. P. Ramaswamy Ayyar, M.A., A.I.I.Sc.

2nd September, 1932.
'Ordinary and Alloy Steels', by Mr. D. V. Krishna Rao, B.A.

Society of Biological Chemists (India).

17th August, 1932.
Mr. Nuggehalli Narayana, M.Sc., A.I.C., A.I.I.Sc., on 'Biological value of the proteins of some Indian foodstuffs'.

24th August, 1932.
Prof. V. Subrahmanyan, D.Sc., F.I.C., on 'The Present Agricultural Depression and a Solution'.

31st August, 1932.
Mr. M. Sreenivasaya, B.A., A.I.I.Sc., on 'Studies of Scars in relation to Sandal Spike'.

Current Science Rupee Fund.

An Appeal.

There is at present no Journal published in India which deals with all branches of scientific work. It has been felt for some time that a publication of this nature would assist in co-ordinating research and in supplying up-to-date scientific information. The matter was discussed by a number of the members of the Indian Science Congress at the Bangalore meeting last January, and it was unanimously agreed that such a Journal was most desirable and an influential Committee was formed to examine the scheme in detail.

It has now been decided to publish a monthly periodical with the title "Current Science". Many offers of help have been received, but before the scheme can be finally launched the financial position must be firmly secured. To effect this the Committee has decided to institute a "Rupee Fund" to which every one interested in science in India is requested t

contribute ONE RUPEE. There are few who cannot spare this small sum. If all were to help, the aggregate together with contributions already promised would suffice to relieve the Committee from pecuniary anxiety.

You are earnestly requested to hand your rupee to one of the gentlemen whose names are noted below or to forward it direct to K. S. Varadachar, Esq., Hon. Secretary, "Current Science," Indian Institute of Science, Bangalore.

Dr. S. S. Bhatnagar, D.Sc., University Chemical Laboratories, Lahore.

Dr. B. Dasannacharya, Ph.D., Professor of Physics, Benares Hindu University, Benares.

Mr. R. H. Dastur, M.Sc., Royal Institute of Science, Bombay.

Dr. P. B. Ganguly, D.Sc., Professor of Chemistry, College of Science, Patna.

Dr. J. C. Ghosh, D.Sc., Professor of Chemistry, Dacca University, Dacca.

Mr. K. D. Guha, Manager, Dairy Farm, Dayalbagh, Agra.

Dr. A. N. Kappanna, D.Sc., The University, Nagpur.

Mr. Khub Ram, M.A., M.Sc., Khub Ram Hostel, Delhi.

Dr. H. Parameswaran, D.Sc., F.Inst.P., Professor of Physics, Presidency College, Madras.

Mr. M. Raman Nair, B.A., A.I.I.Sc., Reader in Chemistry, University of Lucknow, Lucknow.

Mr. S. Ranganathan, M.Sc., A.I.I.Sc., Pasteur Institute, Coonoor.

Mr. M. Rangaswamy, B.A., A.I.I.Sc., Asst. Physico-Chemist, The Lac Research Institute, Ranchi.

Dr. M. N. Saha, F.R.S., University of Allahabad, Allahabad.

Dr. H. K. Sen, D.Sc., D.I.C., University College of Science, Calcutta.

Rai Bahadur Shiv Ram Kashyap, B.A., M.Sc., Professor of Botany, University of Punjab, Lahore.

Mr. B. N. Sreenivasaiah, M.Sc., Meteorological Office, Poona.

Rao Bahadur B. Viswanath, F.I.C., Government Agricultural Chemist, Coimbatore.

BANGALORE,
July 28, 1932.

The "Current Science" Working Committee.

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CONTENTS

N.B.—Contributors and Advertisers—please see notice in the inside cover of back page.

Science and Statesmanship.

IT may be presumed that the chief outcome of the political conferences which have already taken place and those about to be undertaken soon, will be the conferment of a large measure of autonomy on the provincial governments. The problem of utilization of this newly acquired freedom for the greatest benefit of India should now engage the closest attention of all the practical statesmen who have taken part in the deliberations of the Round Table Conferences. Few will dispute the truth of the statement that the noblest exercise of freedom is service to humanity, and perhaps the best equipment for this task is a general diffusion of scientific temper among the people and a severe discipline of Truth on the part of the statesmen. "Men little think how immorally they act in rashly meddling with what they do not understand. Their delusive good intention is no sort of excuse for their presumption. Those who truly mean well must be fearful of acting ill." These words o Burke ought to be engraved on the hearts of the politicians who wish to enter the portals of the new Indian legislatures and those of the statesmen who will control and direct the affairs of the State. If in 1914 they had been taken to heart or even remembered by politicians, it is reasonable to suppose that the world would not have witnessed the appalling catastrophies nor been subjected to a long train of apparently incurable economic miseries.

A mechanized mind and a vague apprehension of the power of science for saving and destroying human life do not constitute the type of mental equipment for dealing with the fortunes and the precious human lives of a whole country. Science was not given to man to be prostituted for destructive purposes and its high ideal was envisaged in the impassioned sentiments expressed by Sir C. V. Raman in the concluding portion of his Dacca Convocation address. He said, "the true justification of science lay in its success in opening out a new vision of the Universe, in giving us an insight into the origin and development of human life, and in fact, in its enabling man to perceive himself in his proper relation to the Universe he lived in. The progress of the human race would depend on the success attained in applying the methods of science to the study and control of human activities

in all their varieties. Science was opening out new vistas of thought, was creating a new religion and a new philosophy which would replace beliefs which were not founded on demonstrable truth but were merely vestiges of man's animal ancestry." In the Introduction to his *Democracy and Liberty*, Lecky says that, "the whole great field of modern scientific discovery seemed out of the range of even such a scholar and statesman as Gladstone" and Gregory records an interesting interview between this eminent politician and Faraday who, when in the midst of explaining an important discovery of his, was superciliously interrupted by the remark, "But, after all, what use is it?" administered an appropriate rebuke, "Why, sir, there is every probability that you will soon be able to tax it." It is true that no scheme of government can be concived in which taxation of human activities can be dispensed with as a superfluity, but it is in the method of its application that the higher visions of statesmen are called into exercise. We are only labouring the most obvious thing when we state that the best part of the revenues must be devoted to the promotion and extension of those activities from which they are derived, to the contribution of the moral and material progress, to the elevation of the racial standards and to the creation of a new and better world. If these objects were to come within the province of practical politics, they are not likely to be achieved by minds imbued with a mild spirit of diplomatic curiosity, a hopeful outlook that things will somehow right themselves in the end, a moderate egotism and an extraordinary capacity for making interminable speeches. The last is a fatal gift which Froude has rightly characterized as, "the harlot of the arts". Our new legislatures should not be permitted to become a paradise of half-baked politicians or a sporting ground of mechanized statesmen.

The constitutional reforms about to be introduced into Indian legislature, will, we think, have to be worked on the basis that politics though inexact is still a science, for, "The material of politics is human nature, its motives honourable and base, its appetite for power and for service, its passions, its prejudices, its memories and aspirations." Very many harsh things have been said, to our mind most unjustifiably, about politicians and politics and their services to the country are apt to be forgotten the moment the causes which called for their exertions, cease to exist. Mr. Baldwin in his Rectorial Address to the University of Edinburgh quotes from that eminent historian and divine, Dr. Figgis, the following passage:—

"In regard to truth, the more one reads of man's notions, about the meaning and method of civil society, the more often is one inclined in despair to say that truth has little to do with politics as it has with politicians."

But by far the hardest thing ever said of the politician is the following, "To the low types which the human race has produced from Cain down to Tartuffe, the age of Democracy has added a new one—the politician." This evil reputation, which few politicians merit, is almost entirely due to the fact that truthfulness prevails less in politics than in the world of science and force is resorted to by the politician for sefety of the State which may involve the suspension of the accepted code of morals, and finally the policy of administration is not based on any fixed laws or principles of science, but permitted to alter in accordance with the creeds of the party in power. When a policy has to be defended, the politician relies more on his persuasive powers of oratory than on his capacity to prove its validity. It is just here that the politician and the scientist part company; but if the scientist were made a statesman, would he adopt politics of the kind where, "a lower standard of habitual truthfulness is alleged to prevail than in the world of science"? Possibly he may introduce the methods of science into statecraft and after all the difference cannot be too wide to keep them separate, with prejudice at any rate to the latter.

One of the hardest problems which the reformed constitution will have to deal with and provide a satisfactory solution for, is the labour question which in India, as elsewhere, is intimately bound up with the country's economic condition and the nature and extent of unemployment among the community. Labour is essentially a scientific problem, almost as exact as any of the physical sciences and unemployment is the result of an unscientific handling of the growth of civil society, the occupations of its members and the correlation of both with the produce of the land. It is obvious that the task of settling labour in anything approaching satisfaction and permanence may seem almost impossible for the reason that human society is a growing organism whose needs

are governed by a complex set of factors. In the investigation of this problem alone, possibly an expert knowledge of more than half a dozen sciences will have to be impressed. An expert knowledge, unassisted by a trained imagination is practically of little importance even in purely administrative functions and in them as well as in carrying on high matters of diplomacy and politics, what the statesmen need are the insight, inspiration and visions which the discipline of science confers. Such a statesman will realise that the preservation of the State is just as much his concern as its enrichment and observe that in economic conflicts and international jealousies the chances of amicable and permanent settlements will be jeopardized if the ardour of patriotism were permitted to outstrip the appreciation of natural laws. We can cajole nature, and even conquer her, but cannot abuse her with impunity. It is in the teachings of science, both physical and biological, that the statesmen will have to find inspiration and infer lessons for their profession of politics and the services of expert scientists, instead of being confined to the laboratory and lecture rooms, should be associated in ever-increasing measure with all the branches of political and administrative functions. Inactivity is comparatively innocuous, but activity without insight must be a destructive force in any calling and is fraught with incalculable danger, especially in politics. The fate and fortune of millions of people cannot eternally be treated as a game of chance in which probability of success is determined by the wealth of rhetoric; but politics, by assuming the definite character of a distinctive branch of a biological science, should pass into the custody of scientist statesman.

The application of the methods of science to the administrative problems which are primarily concerned with the life and affairs of restricted geographical areas, must eventually contribute to the general progress of the people as a whole. Certain departments of the public service such as education, agriculture, medicine, engineering and forestry, are scientific in their needs and purposes, and only men who have actually lived these sciences can visualize the power and possibilities which they hold for making human life richer, happier and fuller. The administrator in charge of these and allied departments needs all the resources and knowledge which an intensive scientific training has imparted to him and his interest in the scientific problems must lead him to organise and supervise research laboratories. Moreover a scientist who has himself engaged in the investigation of special problems in research laboratories would, in certain respects, make a more competent administrator of these special departments in which his expert knowledge and his powers of organization would be of inestimable value in controlling and directing their affairs satisfactorily and efficiently. It is not in the scientific departments alone that men with wide scientific experience of teaching and research are required, but in almost every conceivable branch of administration there is need of the application of scientific methods in the treatment of general and special problems which have anything to do with the management of human activities on any scale. It is true that men and their affairs cannot be dealt with as chemical substances in the laboratories and the test-tube and mortar may not be the instruments of administration or of the transaction of high political matters. Though the means of investigations may differ, the form of procedure must be scientific, consisting of observation, analysis, verification and deduction of general laws. But this is not our position. The whole government machinery must breathe a scientific spirit, and administrators must possess an attitude of mind which seeks to justify not by faith in creeds and undemonstrable theories but by verification of evidence. Statesmen have fallen into the common mistake of classifying things and thoughts as scientific and political, but the position of the man of science is that there are no scientific subjects and scientific thoughts implying topics and ideas about scientific matters but, "the subject of science is the human universe" embracing not only the facts and phenomena of this universe, but "everything that is or has been or may be related to man". The qualities therefore that go to make the scientific mind are precisely the attributes that go to make the statesman's mind, for the "nature of both must be one which vibrates in unison with that of which it is in search".

The main concern of statesmen must be the orderly progress of the human race and it is possible of attainment only by imparting to the men and affairs of the government a scientific outlook, attitude

and method. Progress, if it is to be real and permanent, must spring from the hearts of the people and the function of statesmen must be to provide the means of stimulating and directing it for the greatest common good. In the reformed administration of the country, where it is proposed to introduce adult franchise, we really wonder whether the education of the people has been of such a character as to enable the general electorate to make the right selection, to weigh between two opposing political issues, or to formulate clearly their public duties and obligations. The primary want of the people which is a condition precedent to their general progress is a wider diffusion of scientific education which would also include a knowledge of those branches of learning, leading to a practical appreciation of an enlightened and well-ordered social and political life, the observance of the laws of public health and principle of hygiene, the inculcation of the deeper meaning and purpose of humanity and the ideals of the higher values of individual and corporate life. In order to secure the attainment of these objects in any measure, the reform of education, the revision of medical ethics and alteration of the complexion of administration should form the immediate consideration of the reformed government. It seems to us that what political philosophy has not succeeded in achieving for mankind, science may yet fulfil.

Unemployment in India.

WE have received a copy of the booklet by Sir M. Visvesvaraya, K.C.I.E., LL.D., on "*Unemployment in India,*" which formed the subject of a public address delivered in Bangalore on the 8th September. The address commences with a critical examination of the present economic situation in India, and contains an analysis of the causes which have led to the unemployment among the general masses of the people and among the educated community. It will be remembered that the Government of India in their circular, after having enumerated the causes which have contributed to the serious state of unemployment on an extensive scale, practically gave up the case as being far too complex to admit an easy or immediate solution. A public pronouncement, setting forth suggestions of practical remedies for relieving the tension of the situation, by a distinguished and resposible citizen, with wide administrative experience and knowledge of practical affairs of men and things, must possess, at the present moment, more than ordinary interest. Our main object in announcing the publication of this important booklet is to focus the attention of the public in general, and of the authorities and men of science in particular, on what may commonly be called the burning topic of the day. We intend to return to this in the next issue of *Current Science* when we expect to be able to deal with the subject from standpoints other than those already examined by us in the editorial for the August Number.

Waterfalls as Habitats of Animals.*

By Dr. Sunder Lal Hora, D.SC., F.R.S.E., F.L.S., F.Z.S., F.A.S.B.,
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IN an earlier paper (1) the animals of the bed of a rapid flowing, shallow, rocky stream were divided into two "sub-associations" and each of these was again divided into three "strata". Further work on the ecology of the torrential streams has made it clear that the habitats should be classified into still finer divisions in order to realize the full significance of animal adaptations, *e.g.*, the correlation of an animal organization with its habitat. So long as the varying gradations in

*Published with the permission of the Superintendent, Zoological Survey of India.

A short account of waterfalls as habitats of animals is given by Pearse in *Animal Ecology*, p. 194, New York, 1926.

a particular environment are not thoroughly understood, the finer adjustments of the animals to their respective external conditions cannot be grasped. It has already been indicated (2) that a portion of a small stream can be classified according to the strength of the current and the nature of the substratum. It was then pointed out that the animal associations vary in accordance with the nature of these factors in an apparently similar environment. Following this line of research I have now subjected waterfalls to an intensive study, and have been greatly struck by the diverse associations of animals that inhabit this perilous situation. By a waterfall I do not mean only the spout of water that falls, but I include in it the vertical cliff of rock, the black pool at its base and the neighbouring parts of the gorge that receive a spray from the waterfalls. Thus defined, a waterfall can usually be divided into the following possible habitats of animals:—

1. Water spout.
2. Lip of waterfall.
3. Vertical rock behind the spout and not directly influenced by the current.
4. Usually habitat 3 is replaced by a slanting or vertical rock over which the water flows.
5. Rocks at the base of waterfall over which water crashes.
6. Rocks at the edge of the current intermittently splashed with the eddies of the turbulent waters.
7. Rocks in the neighbourhood of waterfalls which receive a constant spray of water.
8. Deep pool at the base of waterfall.

Even a casual consideration of this classification will show that the conditions of life in different situations must be different, and consequently, the association of animals inhabiting each division must also be different. It may, however, be indicated that there are no hard and fast limits, and that where the habitats grade into one another, the animal associations also overlap one another. I shall now define the possible divisions of waterfalls in terms of ecological factors.

The waterspout lacks solid substratum and in the column of falling water there are no permanent inhabitants, but occasionally fish, such as salmon, mahseer, etc., when ascending streams for the purpose of spawning leap through waterfalls. Large waterfalls or cataracts, however, form effective barriers for the ascent of even these muscular fishes.

The existence of animals on the lips of waterfalls must seem very precarious. It has, however, been shown (1) that the lips of waterfalls can be divided into two categories ecologically, those in which the rocks are covered with vegetation and those in which the rocks are bare. Vegetation, besides affording shelter, provides a secure substratum which enables animals to cling to it by means of hooking devices. On a bare rock much firmer grip is required for stability of movement, and consequently the fauna is relatively poorer. Blepharocerid larvæ (Diptera) and nymphs of *Iron* and *Baetis* (Ephemeroptera) are found on bare rocks, while among vegation the fauna is much richer and varied, and mainly consists of the torpedo-shaped clinging larvæ of Diptera, Plecoptera and Ephemeroptera. According to the strength of the current, the fauna varies considerably in this habitat.

The vertical face of rock behind the column of falling water, but not affected by it, is a place of safety for several kinds of insects, watermites and other small animals. The mosses that grow in this situation afford protection and substratum for anchorage to a number of small organisms. There are certain species of birds that make nests in this habitat. The fauna here varies with the amount of moisture available, and if there is a regular flow of water over the rock (as in habitat 4), fishes may be observed sucking their way up the cliff.

Sometimes the falling column of water flows over smooth, slanting rocks and in such cases the nature of the fauna depends upon the rapidity of the current. If the current is not very fast Caddis-worms of several types are found, but in swift waters Blepharocerid and *Simulium* (Diptera) larvæ abound. Fishes, such as *Garra*, and tadpoles, as those of *Rana afghana*, are also found climbing upstream in this habitat.

The animals that live at the base of a waterfall must be able to withstand a tremendous crash of water. I have collected chiton-like larvæ of the Blepharoceridæ at the base of small falls. It is presumed that the chiton-shape of these larvæ enables them to take the firmest possible hold. The only other animals that were found in this situation were the pupæ of Caddis-flies, but they occurred on the sides of stones and not

on their upper surfaces over which the water fell. According to Dodds (3), the nymphs of *Bœtis bicaudatus* live on rocks where water pours upon them with considerable force.

The rocks in the immediate neighbourhood of the current constitute a very important habitat in this environment, for they afford places of safety for the pupæ of insects and also provide substratum to the adults for egg-laying. In this situation the animals are less liable to be swept away by the current, though they are kept moist by an intermittent splashing or by the dribbling of water from the lip of a waterfall. From here the larvæ migrate into swifter waters, and the pupæ can let out the adults in comparative safety.

The rocks at a little distance away from the waterfall are kept moist by a spray. A large number of moisture-loving animals live in this habitat, but the most striking are the larvæ and pupæ of Psychodidæ which were very common in streams round about Tista Bridge below Darjeeling. These insects live on bare rocks and their earlier stages resemble those of the Blepharoceridæ superficially. Some interesting Copepods have been collected from among mosses. The fauna varies according to the nature of the substratum in this habitat.

The fauna of a pool at the base of a waterfall is very different. The water does not flow very rapidly in it, but it is highly oxygenated. Migratory and other fishes are found in it. Frogs, insects and their larvæ, leeches, molluscs, etc., are all found in these pools.

From the above it is clear that the habitats of animals are as specific as the characters of the species, and probably equally difficult to define. Though our knowledge of the classification of animals has made great progress, unfortunately our knowledge of their habits and habitats is very meagre. It is generally conceded at the present time that "Structural modifications shown to be adapted to particular habitats or modes of life seem to be more characteristic of genera or groups of higher ranks than of species" (4). Generally speaking, the factors strength of current, nature of substratum, amount of moisture, etc., used above for classifying waterfalls, influence groups of animals and mould them to similar lines. Possibly the finer gradations of these factors distinguish species. As an illustration we may take the three species of *Bœtis* described by Dodds (3 & 5) from Colorado living on rocks in swift currents. *B. tricaudatus* with three caudal cerci lives in currents flowing at the rate of 5 feet per second; *B. intermedius* in which the middle caudal cercus is decidedly shorter, lives in waters flowing as much as 8 feet per second and finally *B. bicaudatus*, in which the middle cercus is represented by a vestige only, lives in places where the water flows at the rate of 10 feet per second.

The reduction of the middle cercus (as well as the modification in the shape of the posterior part of the body) can thus be correlated with the increased swiftness of the current and the modification is useful in imparting to the animal perfect stream lines. It is clear, therefore, that minute differences between species, when studied ecologically, can be correlated with the *intensities* of certain factors in their environments.

The study of Animal Ecology is growing in importance, and it is reasonable to expect that some international standards of the classification of habitats and of nomenclature will be fixed before long to save the new branch of science from the fate that has overtaken Taxonomy.

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South Indian Neolithic Culture.

By M. D. Raghavan, B.A., D.A. (Oxon.), F.R.A.I.

THE sources of information from which Man's early culture history may be elucidated are mainly two-fold. On the one hand, there are the actual relics of antiquity, whose relative position in the chronological sequence is determined by their position in the deposits in which they are found, and by their associations. On the other hand, there are important data to be derived from the study of the living races and peoples who have continued in a condition of arrested culture,—such are the Bushmen, the Australians, the American Indians etc., whose conditions of life afford examples of persistence of Stone Age conditions into modern times—the first is the archæological and the second the ethnological method of investigation.

The recognized divisions of time before the existence of historical records are named after the principal materials used for the manufacture of tools, weapons and utensils; and the Stone Age which preceded the use of any metal is now sub-divided into periods or phases, and named generally after type, stations or localities where the particular industry is best represented. Thus considered there are three main divisions:—Eolithic or dawn of Stone Age, Palæolithic or Old Stone Age and Neolithic or New Stone Age.

Researches into the prehistoric archæology of Europe show that early Palæolithic man made implements having a thick wedge-shaped edge tapering to a point with a heavy rounded butt opposite, which must have been held in the hand and used for hacking or chopping. This is now generally known as a 'hand-axe', which is a free translation of the French name, *coup-de-poing*. The next step forward is marked by implements of broad ovate form in which the cutting edge extends all round and the tool is more symmetrically shaped. Some of these sharp rimmed implements may have been hafted for use as axes or knives, but this can only be conjectured. No remains whatever have been found of the hafts of these Palæolithic implements. Assuming that the handles were invariably of wood, it is not surprising that most of them should have perished without leaving any trace. No undoubted modern implements of these types are known, and they were not made by Neolithic man.

Rude implements of quartzite found in very great abundance all over South India bear marked resemblance to, and are identical with, the European forms of hand axes referred to above, and evidently relate to a period of culture strictly conformable with the Palæolithic culture of Europe. While the implements of the Palæolithic peoples of Europe passed through various stages of development evidencing a chronological sequence of comparatively well-established culture phases leading to the distinctive culture of the Neolithic age, the course of transition has not been so clearly traced in India, so that the hiatus between the Palæolithic and the Neolithic ages is much more emphasized and is left largely unfilled.

In the Palæolithic age, stone implements were never ground or polished, whereas Neolithic implements were frequently ground or polished. But the reason for its tardy appearance is as obscure as its origin, seeing that there was nothing to prevent the men of the old Stone Age, particularly in Europe, from treating flint in this way as they had treated bone tools. It is now thought that the new method reached Western Europe at the same time as the idea of building dolmens over the dead; and most of the implements finished by this means are axe heads generally called 'celts'. This term is derived from a latin word supposed to mean 'chisel', and has nothing to do with the people called Celts or Kelts.

While the working part of the Palæolithic hand-axe was the point and the side edge all around, the butt being simply for grasping, in the celt the broad butt has become the sharp business end, the point is of secondary importance and the side edges are no longer used. The celt is usually used mounted at right angles in a wooden handle and used like a modern axe. A celt is thus an axe-head of hard stone with a cutting edge at the broad end, a butt more or less pointed, the sides or edges in nearly straight lines both in the side and front views, the whole or part being finished by grinding after being chipped into shape.

These stone axes are, no doubt, the best known implements of the Neolithic age, and they are also the most widely distributed products of the Stone Age in other parts of the world. Their shapes vary within somewhat narrow limits, but they all agree in having a broad cutting edge, the butt-end being usually blunt. Some of them are roughly shaped by mere flaking and they may belong

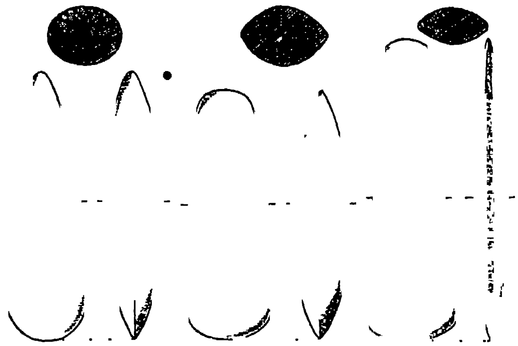
to a period previous to the introduction or discovery of methods of grinding and polishing. Some unpolished implements are no doubt unfinished specimens.

Speaking generally, four stages may be discerned in the manufacture of a Neolithic celt. In the initial stage we get an implement which is roughly chipped into shape. In the next stage, the implement is advanced a stage by 'pecking', *i.e.*, breaking down the angles of the different chippings with a sharp pointed instrument with the object of decreasing the quantity of material. In the third stage, the implement is ground and all excessive roughness removed, and in the final stage, the ground surface is polished. The implement is thus complete and is ready for hafting.

In making an implement from a block of stone, a stone hammer was used for striking blows to reduce the stone to proper form. In the manufacture of the larger implements a suitable block was chosen and brought into shape by a succession of blows, each blow removing a portion of the stone. The implement was thus the 'core' or the central part of the stone, the flakes removed being either discarded or, if suitable in shape, used for making into smaller implements such as scrapers, knives and spear heads.

Methods of grinding and polishing were no doubt of later origin than the processes of battering, pecking or flaking. In Europe, the hardness of the favourite material flint would delay or prevent the discovery that an implement might often be most easily finished by rubbing it on a suitable piece of rock. In India the stones were more easily worked, and lent themselves more readily to grinding and polishing. It is probable that the art of grinding and polishing was introduced into Europe from the East. As to the methods of grinding and polishing little need be said. A fixed grind stone in the form of a slab of rock has been widely used, such as the rock surfaces discovered in the Bellary District by Mr. Bruce Foote, on which well-polished grooves had been worn by grinding the celts to a sharp edge. Similar grooves were found in other localities in South India. Smaller whet stones have also been widely used for both grinding and polishing. The extreme degree of polish on some stone implements is an evidence of great pains spent in the process. It may be that the polishing of stone implements was in the first case the result of the observation that implements in frequent use acquired a polish especially at the cutting edge.

Most of the stones are less easily flaked than flint. Quartzite is particularly refractory and the flaking is difficult to control. Quartz is still worse in this respect and lends itself very badly to being chipped into any shape, for which reason it was very rarely used by the South Indian Palæolithic peoples. With the change in the method of working tools and weapons came an equally great change in the material the Neolithic people selected. Instead of the light-coloured quartzite chosen by the Palæolithic people, the South Indian Neolithic men chose rocks of superior toughness and tenacity such as trapoid rocks, diorite, basalt etc.



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The variety of implements produced by the Neolithic people is also much greater than that made by the Palæolithic people. In the celt group several varieties have been distinguished. Three of the best known types are illustrated in the order in which they are thought to have been made: (1) A primitive form with a pointed butt, a cutting edge of oval outline and an oval cross section approaching a circle. (2) The butt becomes blunt and then broad, while the curve of the cutting edge is reduced, and the cross section becomes an oval sometimes pointed at both ends as the sides are sharpened. (3) The next important stage is the thin butted celt which has a sharpened butt (like a second cutting edge), an oblong section due to the sides being ground flat, and a cutting edge with slight curve approaching a straight line. While the pointed butt is more commonly met with in South India, the sequence is continued by several other varieties. One of the most interesting types is the broad and thin celt foreshadowing the earliest type of iron axes which differ from all the rest. There is the battle axe type of

celt which is short and thick. A rare and aberrant form is a thin celt with its sides bevelled almost to a sharp edge.

The word celt is often applied to implements of the type of adze heads or chisels. Modern stone axes of Neolithic type have been found in many parts of the world, and specimens from the Pacific Islands, America and other regions are often practically identical with the celts of the Neolithic Age. The axe or adze is the most important tool of wood-working peoples, since it is essential for the procuring and shaping of material for huts, canoes and other wooden structures. Implements of this form have been used in primitive agricultural works and some of them may be regarded as hoe-blades. It is often impossible to decide whether a given stone celt was used as an axe-head, an adze-head or as a chisel. The adze-head which is adapted for attachment to a haft in the same way as the axe-head, but with the edge of the blade transverse to the line of the haft, may be distinguished from an axe-head by the fact that one of the faces in the adze is bevelled off at the edge. The chisel has a wedge-shaped edge and is usually narrower than either axe- or adze-head.

The prehistoric localities discovered in South India unmistakably show that the Stone Age peoples were widely distributed over the country with the exception of the mountainous and forest regions of the West Coast where few relics have been found of these ancient races. Their distribution seems to have been considerably influenced by the accessibility of the materials suitable for their implements. Thus numerous settlements of the Palæolithic race have been formed within the bounds of the quartzite-yielding districts of Chingleput, North Arcot and Nellore than elsewhere in South India. The Kistna river becomes the northern boundary of these peoples, their traces getting less the further north we go. The Palar river similarly forms the southern boundary. Neolithic remains are most numerous in the northern parts of the Deccan plateau, where materials for their implements are more plentiful. Few traces of them exist south of the Cauvery.

The chief centre of the Neolithic peoples in South India was Bellary where many settlements have been discovered. The first discovery of any Neolithic celt in India was made in this district in 1872 by William Fraser. This was followed by a systematic survey of the district by Bruce Foote disclosing several Neolithic settlements. Shevaroy hills in the Salem district are also rich in Neolithic implements and other relics of a civilization rooted in the depths of time, such as the megalithic monuments. Neolithic sites have also been discovered in Kurnool, Guntur, Anantapur and Cuddapah districts and in several localities in Hyderabad State.

The first appearance of pottery occurs in Neolithic Age. Yet no place has been met with in South India where the making of vessels has been carried on on a large scale. Typical Neolithic pottery is dull coloured and rough in shape with little decoration beyond impressed or incised patterns, as distinguished from Iron Age pottery, with its better polish and finish and brighter colour.

In the Neolithic Age we also get indications of the domestication of animals. This implies that Neolithic man was largely pastoral, with a food supply rendered more or less constant by domestication. The increase in sedentary habits had an inevitable tendency for the people to group themselves in communities. And with aggregation in communities, it was no longer essential for each individual to be self-supporting. With this tendency, progress in agriculture was rapid.

Towards the close of the Neolithic Age we get the first evidence of the use of metals. While archæological discoveries in other lands disclose a Bronze Age prior to the Iron Age, in India there is nothing to warrant us to put forward such a claim in favour of bronze, the prehistoric peoples of India having obviously passed directly from the use of stone to the use of iron, as is clear from the iron implements excavated from the prehistoric burials in South India, though the process was necessarily very slow. Prehistoric men no doubt began to use iron as they had used stone, not recognizing it as iron but as something harder than stone and better adapted for making into implements. The earliest iron implements were no doubt mere copies in iron of the Neolithic celt.

In the next stage of prehistoric culture the art of smelting and working iron was introduced and gave it the name of the Early Iron Age. The much greater ease and rapidity with which weapons and tools of greatly improved quality could be produced in iron, led to the making of stone implements to be gradually abandoned.

Bruce Foote's account of the Bellary Hill

Settlement shows that in South India the Iron Age followed hard on the Neolithic Age, remains of the two phases of culture occurring in the same sites. It is evident that in a very large number of cases the Iron Age people must have occupied the old Neolithic sites, and celts and other stone implements are found mixed up with the highly polished and bright coloured Iron Age pottery, as has been found at the ancient village site of Pati at Peddamudiyam village in Cuddapah district excavated by the Archæological Survey in 1905. The site has been successively occupied by peoples in varying stages of civilization from prehistoric to modern, and finds of Neolithic stone implements, pottery, implements in iron, stone lingams, bronze rings and gold coins and ornments have been found, including a small find as recent as February last. From the evidence afforded by several such ancient sites in the districts of Deccan and in Mysore, it is very reasonable to conclude that the iron workers were the direct successors of the Neolithic people.

The Neolithic and Iron Age peoples constructed megalithic monuments such as the dolmens and stone circles which are found in various parts of South India. They are found on the Palni hills in the Madura district, on the Shevaroy hills in Salem district, on the Nilgiri hills, in Coimbatore, Malabar, Coorg, Hyderabad and elsewhere. It is observed that the distribution of megalithic monuments agrees with that of the Neolithic and Iron Age sites. This association combined with the Neolithic and Iron Age remains met with in these tombs enable us to conclude that these graves were constructed by these early races. These megalithic structures afford evidence of a relatively high social organization and of a well-developed religious cult.

The interest manifested in the study of the early chapters in the story of Man's Culture is steadily increasing, and there are now but few regions which remain totally unexplored for traces of early Man and of his activities. It is, however, a sad reflection that South India is of all parts of the globe, about the least explored region, though there is evidence of its having been populated by very ancient races in the dim distant past, and shows in its present primitive population cultural contact and racial linking with the primitive races of Indonesia, Melanesia and Polynesia. Bruce Foote's investigations have not been followed up by any excavations of prehistoric sites, and it is to be hoped that the several administrations responsible for the Government of the different parts of South India, and the learned bodies, such as the Universities, will wake up to the great need for exploring the prehistoric archæology of South India.

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The Affinities of Chætognatha.

By C. C. John, D.SC., D.I.C. (London).

SOME of the observations on the anatomy and development of the Chætognatha seem to be of importance in throwing light on the systematic position of the group. Various authors have assigned it to widely different phyla taking into consideration certain sets of characters in support of their individual views. As all these theories have been reviewed by Burfield,* it is proposed at present to deal with only some of the more accepted views put forward by Huxley,† Doncaster‡ and Patten.§ Huxley was the first to state definitely that the Chætognatha shows a great deal of resemblance with Annelida; and later this view has been emphasized by Hertwig¶ and others. In support of this view it was pointed out that as in Polygordius the spacious body cavity of the trunk is divided by a longitudinal septum, which supports

*Burfield, S. T., "Sagitta," *L. M. B. C. Memior*, 1927.

† Huxley, T. H. "Observations on the genus Sagitta," *Brit. Ass. Report*, Vol. XXI, 1852.

‡ Doncaster, L., "On the development of Sagitta, with Notes on the Anatomy of the Adult," *Quart. Journal Micr. Sci.*, Vol. XLVI, 1902.

§ Patten, W., *The Evolution of Vertebrates and their Kin*, Churchill, London, 1912.

¶ Hertwig, O., "Die Chætognathen," *Jen. Zeitschrift*, XIV, 1880.

the alimentary canal. There are four bands of striped longitudinal muscles which show a pinnate arrangement of the fibres. The ventral ganglion corresponds to the ventral nerve cords of Polygordius, the body is divided into three segments by two transverse septa, one in the region of the neck and the other behind the anus, and the prehensile spines are similar in structure and formation to the Chætopd setæ, which, however, are absent in Polygordius. These facts have been considered sufficient reasons for associating Chætognatha with Annelids. On this Annelidan theory the Chætognatha are three-segmented Annelids, which having adopted a swimming mode of life are greatly modified from the true Annelidan type.

Against this assumption it has been argued that the apparent similarities are only superficial and so do not indicate the true affinities of the group. The importance of metameric segmentation in deciding the affinities of the group is denied by Doncaster, who points out that it arises in various ways independently in different groups. Further, it is stated that the absence of nephridia, vascular system and oblique septa, greatly weakens the supposed resemblance and that the Chætognatha and the Annelida differ fundamentally in their types of development. In Annelida the mesoderm originates from pole cells whereas in Sagitta it develops from the anterior folds of the archenteron. Though the embryonic development is so greatly abbreviated to be of any importance in helping to solve the problem of its affinities, Doncaster emphasizes the absence of any stage which resembles the trochophore, as a deciding factor against this theory. The transverse septa arise by the meeting and fusion of the somatic and splanchnic mesoderm, so that the three divisions of the body which result from these are not similar to the annelidan segments nor are they homologous with one another. The further difference between the two groups concerns chiefly with the structure and disposition of the trunk muscles. They are arranged in four longitudinal rows and the muscle fibres consist of an outer contractile portion adjoining the basement membrane and an inner nucleated protoplasmic part forming a continuous lining of the trunk and tail coelom. This structure recalls the condition found in Nematoda and in this direction, therefore, Doncaster tried to discover the relationship of the group. According to him the oviduct of Sagitta is comparable with that of Nematoda in being continuous with the ovary and in being formed from an epidermal thickening. These led him to conclude that the nearest allies of Chætognatha are the Nematoda and that the two groups diverged very widely owing to differences of habit, the former having become greatly modified for pelagic life. Based on this theory he regarded the Chætognatha as an off-shoot of a primitive coelomic stock which gave rise to the Annelids and the Nematoda.

This theory of Doncaster endeavours to reconcile the older ideas with his own observations without greatly shifting the systematic position of the group, but later Patten* discarded all the older theories and tried to establish an Arthropodan affinity of the group. This view was advanced by Grassi† who found resemblance between the cerebral ganglion of Chætognatha and Arthropoda and compared the visceral ganglion with the ganglionated chain of the latter. Patten regarded the Chætognatha as a modified descendant of the primitive Arthropod, retaining even in the adult some of the important characters of the group. According to him the body is divided into three regions: head, thorax and abdomen. The head is covered over by a hood which he compares with a bivalve mantle. The retrocerebral organ, situated in the postero-median margin of the brain, represents the parietal eye of Nauplius. The genital cells appear very early in the segmenting egg which correspond in their early location and position with similar cells in many Arthropod embryos.

It is hardly necessary to enumerate all the points brought forward by him as they do not serve any important purpose when it can be shown that the fundamentals themselves are doubtful. His conclusions are mostly superficial and based on rather inaccurate observations which will not bear closer examination. In a previous paper‡ on the Anatomy of the Head of Sagitta, I have shown that the prehensile spines originate from seta follicles comparable to the secondary matrix of permanent setæ of Annelids, and that the retrocerebral organ very closely resembles the cerebral organ of Monostyliferous Nemerteneans in structure and function.

The retrocerebral organ is very vestigial in Spadella, but in those species in which it occurs it consists of a median opening and two appendages situated in the posterior border of the brain. From the median opening a canal passes on each side into the appendages. Each appendage is formed of large cells composed of finely granular substance surrounding the axial canal. At its anterior end an aggregation of nerve cells enter the organ from the brain and becomes wedged in between the granular cells. In this structure of the retrocerebral organ it is impossible to discover any resemblance with the parietal eye of Branchipus or Apus. In Branchipus it is a trilobed vesicle with retinal cells and dense black pigment. In the retrocerebral organ black pigment is absent and there is nothing corresponding to the retinal cells. The two appendages and the median opening suggest a remote resemblance to a trilobed organ, which seems to be the only reason for comparing it with the parietal eye.

As the development of Chætognatha is very greatly abbreviated, the evidences for deciding the affinities are to be gathered mainly from a close study of the adult anatomy and this leads more and more to strengthen the first conclusions of Huxley that the Chætognatha are related to the Annelids.

The chief objections to accepting this view have so far been that in Chætognatha, oblique septa, nephridia and blood vessels are absent. Though no blood vessels have yet been discovered,

* Patten, W., *loc. cit.*

† Grassi, B., "I Chætognati," *Fauna i. Flora des Golfes von Neapel. Monogr.*, V, 1883.

‡ John, C. C., "On the Anatomy of the Head of Sagitta," *Proc. Zool. Soc., London*, 1931.

it has been shown that 'oblique septa' are present in the trunk cavities of Spadella exactly as they occur in Polygordius.

(The term 'oblique septa' as ordinarily used in Polychæts and some Archiannelida conveys a very misleading homology. These are not true septa, but only small bands of oblique muscle fibres arranged parallel to one another with narrow spaces between each successive bands through which the so-called lateral cavities freely communicate with the median cavity; the same is true of *Spadella cephaloptera*.)

The female genital ducts in Chætognatha were first regarded as modified nephridia, but Doncaster dismissed this idea on the ground that while true nephridia are mesodermal in origin the genital ducts in Sagitta arise as epidermal thickenings. Later Stevens* showed that their real origin is as folds from the lateral mesoderm at the posterior end of the ovary.

The buccal cavity in *Spadella cephaloptera* is evertible.† In the normal condition the mouth lies in an antero-ventral position at the bottom of a shallow vestibule, but when the mouth is opened the vestibule is completely evaginated and the pharynx projects forward, recalling the similar process in Polygordius.

When we turn to palæontological history of the group we get some more convincing proofs in support of the Annelidan affinities. Chætognatha is very poorly represented in fossils. Only three specimens have been recorded and these were found in the middle cambrian formations in British Columbia. These fossil forms, *Amiskwia Sagittiformis*, Walcott,‡ are about 20 mm. long and possessed a pair of long cephalic tentacles, a single pair of lateral fins and a tail fin. The alimentary canal extended a little beyond the centre of the tail. Its occurrence in the shale with small free-swimming Crustaceans indicates that it was a free-swimming animal. The discovery of this fossil form greatly helps to explain one of the objections against the Annelidan affinity. It has been argued that the three divisions of the body, head, trunk and tail, do not correspond to metameric segments as the alimentary canal terminates in front of the tail septum. In the fossil form the alimentary canal extended to the middle of the tail and in Spadella there is a secondary space between the median septa behind the anus into which a small clump of endodermal cells projects from the hind end of the alimentary canal. This clearly shows that in the primitive forms the alimentary canal extended to the end of the tail and during later periods it was characterized by a tendency towards reduction, which finally masked the homology of the last segment.

The occurrence of prominent cephalic tentacles in *Amiskwia sagittiformis* also brings closer the similarity to Polygordius and their existence in a vestigial form in *Spadella cephaloptera* shows to some extent the degenerative process at work during the evolution of the modern representatives of the group. The Chætognatha are therefore quite possibly derived from a primitive Annelidan stock through a regressive or degenerative process coupled with the adaptation to a pelagic life. MacBride has stated that the "Fundamental type of habit common to all Annelids is a burrowing mode of existence and from that coupled with a wriggling method of locomotion during their occasional excursions we are able to deduce the main peculiarities of their adult structures." The same easy generalization extended to comprehend an active pelagic mode of life explains the probable factor in the divergence of Chætognatha from the true Annelidan type.

The absence of a trochophore stage has been very much emphasized by previous workers against the Annelidan theory. The development of an individual during its embryonic and larval stages is regarded as a recapitulation of its phylogenetic history, but apart from being a mere replica of the past it is evident that the larval stages serve a very important purpose to the future individual which develops from them. In cases where the embryo hatches out at a very early stage in development the larva is thrown upon its own resources and a long period of larval life ensues, before the adult form is assumed, during which time the larva feeds and moves about by its own activity. In other cases where the adult individual is fixed throughout life or is semi-sedentary in habits the existence of a larval stage serves an ecological function. If these are regarded as the chief functions served by the larva, one sees no reason why a larval stage should be expected during the development of Chætognatha. The majority of Chætognatha are planktonic, so that a larval stage does not serve any useful purpose. This might have, therefore, led to the abbreviation of its life-history as in the case of terrestrial Oligochæts, where the eggs develop inside a cocoon and hatch out as small worms with all the adult features. Just as the transition to a terrestrial mode of life cut short the free-swimming trochophore stage in Oligochæts, the adoption of a planktonic life in Chætognatha led to a shortening of the developmental period and the disappearance of a larval stage corresponding to the Annelidan type.

* Stevens, N. M., "Further Studies on the Reproduction in Sagitta," *Journ. Morph. Philadelphia*, XXI, 1910.

† John, C. C., "Habits, Structure and Development of *Spadella cephaloptera*" (in the press). *Quart. Journ. Micr. Sci.*

‡ Walcott, C. D., "Middle Cambrian Annelid," *Smithson. Miss. Coll.*, Vol. LVII, 1911.

Letters to the Editor.

The Electronic Theory of Triad Mobility.

As is well known, by far the greatest number of tautomeric triad systems belong to the mobile hydrogen type, which can be represented by the general expression [H] X – Y = Z ⇌ X = Y – Z [H]. The moment that the electronic duplet is identified with the covalent bond, it will be seen that the reversible change involves an internal displacement of electrons, accompanied by the external transference of the so-called "mobile" hydrogen atom, which is now known to be a proton in so far as it is "mobile". The process of reversible isomeric change in systems of this type can be regarded as a three-stage process involving: (i) the ionization or dissociation of the mobile hydrogen atom, (ii) the distribution of the negative charge left on the triad residue by means of electronic displacements of the type characteristic of this type of triad mobility, and (iii) the re-association of the proton with the organic anion at the points at which the electrical charge has become localized:—

$$\overset{\text{H}}{\overset{|}{\text{X}}}-\text{Y}=\text{Z}\rightleftharpoons\overset{\ominus}{\overset{|}{\text{X}}}-\text{Y}=\text{Z}\rightleftharpoons\text{X}=\text{Y}-\overset{\ominus}{\overset{|}{\text{Z}}}\rightleftharpoons\text{X}=\text{Y}-\overset{\text{H}}{\overset{|}{\text{Z}}}$$

On the basis of this, it will be seen that mobile hydrogen tautomerism is merely a form, and of course the best known form, of the more general phenomenon of *cationotropy;* the picture for which will be the same as that for mobile hydrogen triad mobility with the exception that the externally transferred ion is a positively charged ion, which may or may not be a hydrogen ion. By means of this the mobility of the metallic derivatives of compounds such as the nitromethanes and β-diketones is brought into line with ordinary triad mobility in which the mobile group is hydrogen; the differences in behaviour between the mobile metal and the mobile hydrogen type being attributable to the different degree of stability of covalency union.

It will be seen furthermore, that on the basis of the electromeric theory just outlined, that the *mobility* of such systems, under definite sets of conditions, will depend essentially on the relative stability of the organic anions within which the *real* isomeric change takes place, and that the *equilibrium* will depend both on the stability of the isomeric anions and the strength of the covalent links by which the cation associates with them.

Cationotropy as such, represents of course only one half of the general phenomenon of triad tautomerism; the other half of which involves a mobile group which dissociates as an *anion*, leaving a cationic residue within which triad tautomeric changes analogous to those of the mobile hydrogen type take place. This half of the picture of triad mobility, which is termed *anionotropy* has only been realized within the last four years by Ingold and Burton, and can be represented in a manner similar to prototropy:—

$$\overset{\text{A}}{\overset{|}{\text{X}}}-\text{Y}=\text{Z}\rightleftharpoons\overset{\oplus}{\overset{|}{\text{X}}}-\text{Y}=\text{Z}\rightleftharpoons\text{X}=\text{Y}-\overset{\oplus}{\overset{|}{\text{Z}}}\rightleftharpoons\text{X}=\text{Y}-\overset{\text{A}}{\overset{|}{\text{Z}}}$$

The mobile groups in this case are, of course, those which possess stability in their anionic form, such as bromine and hydroxyl, and it has been shown by Ingold and Burton that the three main factors which facilitate anionotropic changes are: (i) the ionising power of the solvent used in the transformation, (ii) the stability of the group A in its anionic form as shown by the strength of the acid HA, and (iii) the capacity of the system to supply electrons to the ionising centre in such a way as to facilitate the dissociation of A in the form of a negative ion.

It has also been experimentally demonstrated by Burton that the group A does leave the system as an anion, and *returns to it as an anion*, by an examination of the isomerization of p-nitro-benzoyloxyhydrocarbons

$$\begin{array}{l}\text{O.CO.C}_6\text{H}_4\text{.NO}_2\\ |\\ \text{CHPh.CH : CH}_2\end{array}\rightleftharpoons\begin{array}{r}\text{O.CO.C}_6\text{H}_4\text{.NO}_2\\ |\quad\\ \text{CHPh : CH.CH}_2\end{array}$$

in the presence of a soluble acetate. Thus if the p-nitrobenzoyloxy group migrates as a p-nitrobenzoate ion and in so doing, definitely separates from the cation, then acetate ions should be able to compete with it during its return. That this is the actual case, was shown by the fact that if acetate ions were allowed to compete with the p-nitrobenzoate ions in this way, a considerable proportion of the material undergoing isomeric change was recovered in the form of acetoxyhydrocarbons.

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A Fossil Pentalocular Fruit from Pondicherry.

SEVERAL years ago Dr. F. A. Bather, F.R.S., then Keeper of Geology at the British Museum, kindly sent me on loan, among other Indian fossils, the petrified fruit shown in the accompanying photograph. The fossil is stated to have been found near Pondicherry. The geological age is unknown, but it would probably be safe to regard it as Tertiary.

There is probably little doubt that the fruit belongs to a dicotyledonous plant, but its exact position in that extensive group has long been a puzzle to me. May I be allowed, through your columns, to request systematic botanists and foresters to come to the rescue by giving me the benefit of their knowledge of tropical angiosperm fruits?

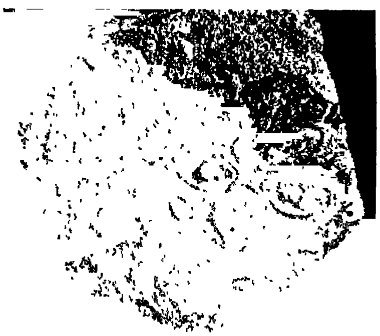

Fig. 1.

The photograph (fig. 1) shows the fruit embedded in a calcareous matrix, which was naturally weathered in such a way as to expose an almost exact transverse section of the fossil. The fruit is syncarpous and pentalocular, with a single large seed placed vertically in each fertile loculus, with its major diameter radial. One of the loculi (No. 5 in the photograph) is abortive; the cavity at * is due to an accident and has nothing to do with the structure of the fruit, as I have ascertained by means of sections. Practically nothing is preserved of the seed contents, but the rather thick and smooth, probably woody, integument shows in seed No. 2 certain features which may be of diagnostic value. In a section examined under the microscope the integument shows two layers, of which the outer is thick and consists of columner cells placed vertically to the surface (fig. 3). As clearly seen in the photograph, the seed-cavity narrows outwards into a beak-like process, at the sides of which the integument is markedly thickened. At this level the beak-like prolongation of the cavity nearly communicates with the exterior, suggesting the proximity of an outwardly directed micropyle (fig. 2). But the thickening of the integument is continued for several millimetres along the

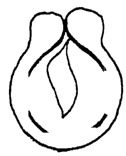

Fig. 2.

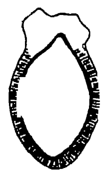

Fig. 3.

Fig. 4. (×1½.)

margin of the seed, and in fig. 3 (drawn from a section of the same seed cut 4 mm. below the level of the photograph), the thickening is equally pronounced, and might almost be described as a caruncle. Only a millimetre or two beyond this level all trace of the thickening has vanished. With my very limited knowledge of modern angiospermous fruits, the nearest comparison that I have been able to make is with the fruit of the sapota (Sapodilla plum, *Achras Sapota*).* With this fruit the resemblance is in some respects surprisingly close, but a very important point of difference lies in the orientation of the seed. In the sapota the micropyle faces the axis of the fruit, while in the fossil, as we have seen, it was probably directed outwards. A cross-section of the integument of a sapota seed is shown in fig. 4.

I need hardly add that I shall gratefully welcome any suggestions that may lead to an elucidation of the systematic position of the fossil.

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August 15, 1932.

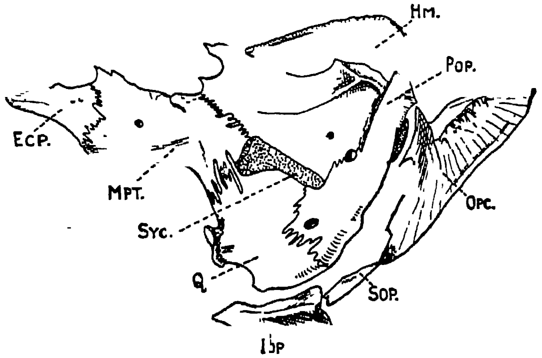
The Siluroid Skull.

THE study of the skull in the family of Siluroid fishes, from a complete investigation of the type forms in eight Indian genera, has thrown light on certain fresh points in the organization of the skull.

The myodome (eye-muscle canal) is said to be absent in Siluridæ (1 & 3). It is so in all the forms except in the primitive *Silundia gangetica* in which there is a definite, though small and vestigial myodome, roofed by the pro-otics and floored by the

* Compare figures in Engler & Prantl, *Nat. Pflanzenfam*, **4**, p. 138 (1897).

parasphenoid and the basi-occipital. It is regarded that there is only one pterygoid bone (metapterygoid) in the skull of Siluroid fishes (2 & 3). But besides the metapterygoid there is a clear ectopterygoid present



The pterygoquadrate bar and the opercular apparatus of Plotosus canius.

Ecp.—Ectopterygoid; *Mpt.*—Metapterygoid; *Syc.*—Symplectic cartilage; *Q.*—Quadrate; *Iop.*—Interoperculum; *Sop.*—Suboperculum; *Opc.*—Operculum; *Pop.*—Preoperculum; *Hm.*—Hyomandibular.

in all the forms. In *Rita buchanani* the ectopterygoid is small and has lost its firm connection with the pterygoquadrate bar. It is attached firmly with the orbitosphenoid. Only a close observation reveals its presence in Rita. It is toothed in Silundia. Silundia possesses a minute entopterygoid also. In this family the suboperculum is stated to be absent (4) or that the first branchiostegal ray represents this bone (2 & 5). While it is absent in the six forms there is a small but definite suboperculum in Plotosus canius and Osteogeneosus militaris. Besides, Kindred has pointed out the presence of a small suboperculum in Amiurus catus. This clearly shows that while it is generally absent, it is vestigial in certain forms and that the first branchiostegal ray cannot be homologized with the suboperculum. A small supratemporal which is firmly articulated with the cranium is present in all the forms. The cranium is platybasic, the cranial cavity extending between the orbits to the ethmoid region. In the advanced forms Arius and Osteogeneosus the cranial cavity stops short about the middle of the orbitosphenoid, only the olfactory nerves piercing through the anterior portion of the orbitosphenoid and ectethmoids.

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August 17, 1932.

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2. Ibid, *Fishes, A Treatise on Zoology*, Edited by Sir E. Lankester.
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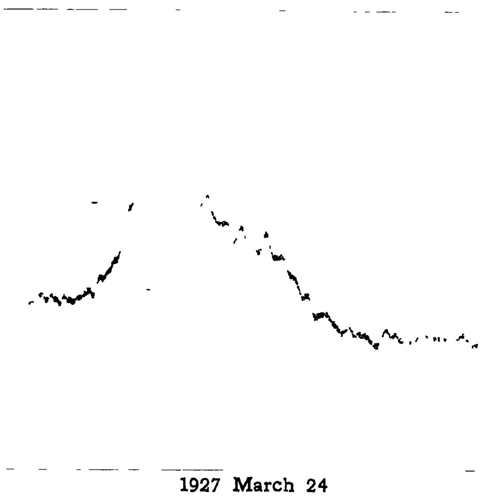
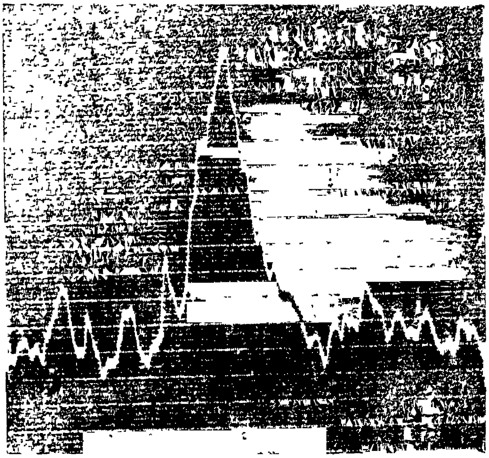
4. G. Boulenger, *Fishes, C. N. History Series*, Macmillan.
5. MacMurrich, *Osteology of Amiurus catus*, *Proceedings of the Canadian Institute*, Vol. 2, 1883–84.

The Structure of Hα Absorption Markings on the Sun.

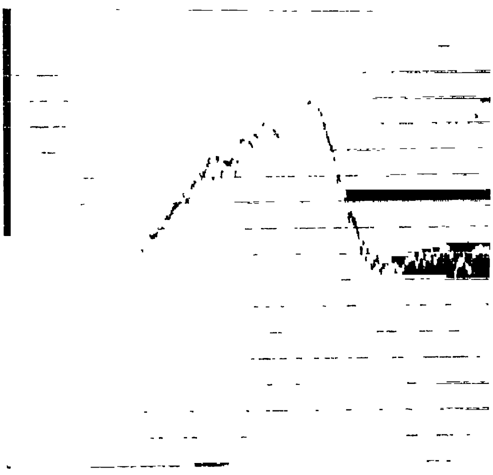
EXAMINATION of a large number of absorption markings in spectro-heliograms of the sun taken in Hα light has revealed that the intensity of absorption is not uniform across the width of a marking. It is found that in every well-defined marking there is a line of maximum absorption running along its length and that the position of this line depends on the lie of the marking on the solar disc. For example, when a longitudinal marking lies along or near the central meridian, the line of maximum absorption runs along the middle and when the marking is farther and farther away from the central meridian, this line shifts towards the limb side and finally, when near the limb, the marking is actually bordered by this line of maximum, so that the absorption falls off abruptly and the general level of intensity of the solar surface is reached. The same phenomena are observed in other cases also. When a marking is radial on the disc, the line of maximum absorption is symmetrically situated at the centre and shifts from



1927 March 24
Marking at Long. 22° W.



1927 March 22
Marking at Long. 5° E.



1927 March 20
Marking at Long. 32° E.

this position towards the limb, when the marking deviates from the radial position.

The accompanying micro-photometer curves show the variation of absorption across the breadth of a longitudinal marking as it transited the sun's disc from the 19th to the 26th March 1927. Only three curves are given here showing the absorption when the marking was (1) on the eastern hemisphere, (2) very near the central meridian, and (3) on the western hemisphere. The symmetrical nature of the middle curve and the shift of the peak in opposite directions, *i.e.*, towards the limb side, where the curve becomes steep, are quite evident.

It is hoped that that these observational facts will afford an important clue to the structure of the absorption markings. The results can be explained if it is assumed that the cross-section of the mass of hydrogen gas involved is roughly triangular in shape with its base up. The subject will be dealt with more fully elsewhere.

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August 23, 1932.

Correlation of Sex and Shell Structure in a Mollusc—*Trochus niloticus* Linn.

MOLLUSCAN shell has attracted the attention of both laymen and scientists alike for a long time. From the scientific aspect a good

Longitudinal Sections of the Trochus Shell.
A. Male of 9.87 cms B. Female of 9.76 cms. in diameter showing the oval and the angular shape of the cavities respectively.

A.N.L.—"Amorphous" Nacreous Layer; *Hy.*—Hypostracum; *N.L.*—Nacreous Layer; *Pe.*—Periostracum; *Pr. L.*—Prismatic Layer.

deal of literature exists on the shape, size ornamentation and structure of the shell; there is a certain number that deals with the relation of the shell to sex. This link, so far, is confined to the size of shell as an indication of the sex. Here, I propose to show that in a mollusc, *Trochus niloticus* Linn. (Top or Pagoda shell) from the Andamans, the sexes can be determined by longitudinal sections of the shell—passing through the extreme end of the suture of the outer lip to the body whorl and the columella. Sections of various individuals ranging from 5–12 cms. in maximum diameter were cut and polished by the usual method.

On examination, two facts emerge. Firstly, the various layers of the shell in both sexes seem to be constant, *i.e.*, it contains the usual three layers of the molluscan shell namely the periostracum (Pe.), the prismatic* (Pr. L.) and the nacreous layer (N.L.). The fourth layer, the hypostracum (Hy.) is found on the columella for muscle attachment. An "amorphous" form of the nacreous layer (A.N.L.) is found to fill in the cavities in the apical region and also line the area where the gonad is lodged. These various layers are labelled in Fig. A. The fact that the "amorphous" nacreous layer completely obliterates the apical cavities and grades down in thickness towards the body whorl, indicates that this is deposited as the animal grows. It is quite probable that this "amorphous" deposit—composed of hard material—is analogous to that found in the shells of *Ostrea edulis*† and that it is deposited to fill in rapidly the space created by the anterior migration of the gonadial twist during growth.

Secondly, the shells of 7 cms. or over in diameter form two definite categories, depending on the shape of the cavities. In the male the shape inclines to be oval, *i.e.*, the angles are obtuse as in Fig. A. This is best observed in the cavities—Nos. 2 and 3 counting from the base—on the left side of the columella. In the female, it is inclined to be angular, *i.e.*, the angles are not so obtuse [see Fig. B]. Again the cavities in the same position illustrate this point clearly. It is therefore evident, that the sex of a mature individual can be ascertained from longitudinal sections. This conclusion was reached after examining sections of about a hundred individuals of known and unknown sex. Further I found that *Trochus niloticus* reached maturity in two years when it attains a size of 6-7 cms. in diameter. Therefore, as would be expected, the shells of about 7 cms. or below in diameter do not show markedly this above difference in the shape of the cavities.

C. AMIRTHALINGAM.

Port Blair and Calcutta.

* The terms used here are those generally accepted by English-speaking authors; those used in a Memoir on *Pila* (*The Indian Zoological Memoirs*) differ from this terminology.

† J. H. Orton & C. Amirthalingam, Notes on Shell Deposition in Oysters, *Jour. Mar. Biol. Assoc.*, 14, 935, 1926–27.

Mineral Metabolism and Hyperplastic Goitre.

BAUMANN, Kurland and Metzer have recently reported an association between calcium retention and hyperplastic goitre caused in rabbits by exclusive feeding on cabbage. S. Ranganathan, working in these laboratories, has failed to find any such association when the goitre so produced is of a size not exceeding 170 mg. per kilogramme of body-weight. But when it is of larger size this association has been observed, though so far only in one animal whose goitre weighed 293 mg. per kilogramme of body-weight. It has been observed, further, that the addition of lime to the cabbage diet increased the goitrogenic potency of the latter during the hot, dry months of the year in this locality—a time when the potency is at its lowest ebb. The addition of calcium made no appreciable difference in the urinary excretion of calcium, magnesium and phosphorus; the serum-calcium values were also within normal limits. It has been noted that while the thyroid enlargement caused by insanitary condition in albino rat fed on a diet composed of cereal grains and fresh cabbage is associated with a signifcant increase in size of the adrenal glands and spleen and a significant diminution in size of the testes and thymus—the size of other organs remaining unchanged (the pituitary gland was not examined)—no such change in size of these organs occurs in association with the hyperplastic goitres produced in rabbits by an exclusive diet of cabbage.

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Nutritional Research Laboratories,
Coonoor, *August* 24, 1932.

A New Disposal System for Municipal Wastes.

IT is universally acknowledged that much yet remains to be done to secure an adequate standard of sanitation to maintain proper health for both urban and rural populations in India. Want of funds has seriously hindered a practical solution of the problem.

A number of fermentative processes have been devised for the disposal of night-soil and town refuse with varying degrees of sanitary and economic success. Recently, great advances have been made by Dr. Gilbert Fowler and his collaborators.* The problem has been attacked lately from a different standpoint at Indore and a very simple and profitable system for sanitary disposal has now been developed on similar lines to the Indore process of composting agricultural wastes.†

The features distinguishing it from other systems known to the writers are that widely varying proportions of refuse to night-soil can directly be dealt with, and that no activation, chemicals, or antiseptics are necessary. The process is being successfully worked at the disposal grounds of both the City and Residency areas at Indore. It is free from nuisance, cheap and simple enough to be handled efficiently by the sweeper-class without supervision. It works equally well under dry and hot, or wet conditions, having withstood a continuous rainfall of 21 inches within 20 days.

The technique is equally adaptable to the needs of large and small communities, with or without a piped sewage system. The authorities at the city depot now expect to earn a handsome revenue from the disposal of waste. A larger quantity of organic manure superior to that obtained at present is manufactured within 3 to 6 weeks. Cultivators have eagerly purchased it, showing they appreciate its agricultural value.

A universally useful organic manure must approximate in composition to natural soil-organic matter, having its nitrogen in stable, yet easily available form. Mere high analysis has only a partial value in the estimation of efficiency in the field. This point has been kept well in view during the elaboration of the process.

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Y. D. WAD.

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August 30, 1932.

* "Recent Experiments on the Preparation of Organic Matter," *Agric. Jour. of India*, **25**, 369, 1930, and subsequent press announcements.

† *Waste Products of Agriculture*, Howard and Wad, Oxford University Press, 1931.

WE have been engaged for the past few years on problems connected with the utilization of town refuse and waste vegetation and our experience has shown that although sullage or sewage (raw or treated) can be sprayed, as such, on the refuse heap, night-soil will first have to be partially liquefied before it can be evenly mixed with the refuse. Under normal conditions the final product has a nitrogen content of about 1 per cent irrespective of the amount of sewage or night-soil added, the extra quantity being lost in the gaseous form. Indications have, however, been obtained to show that in presence of (1) activated sludge as the starter there is evidence of fixation of atmospheric nitrogen, (2) minute quantities of certain inorganic salts like those of copper, zinc or titanium there is not only a marked change in the composition of the active microflora, but also greater conservation of carbon and nitrogen in the heap than would otherwise be the case.

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A New Enzyme Preparation.

THE inadequacy of the form in which enzyme preparations are at present available on the market for general laboratory use, led us to the preparation of enzyme-papers which promise to offer a very convenient mode of handling enzymes quantitatively with rapidity and ease. The preparation consists either in dipping filter-papers in enzyme solutions or spraying the solution on to the filter-paper and desiccating the paper in vacuo over calcium chloride. The papers are standardized in terms of enzyme activity and expressed as units per sq. cm. The enzyme content can, therefore, be calculated directly on the area of the paper used. Filter paper preparations of diastase and emulsin have yielded successful results and have kept their activity for over a year. In

the case of hygroscopic enzyme preparation like pancreatin or pepsin, however, it is obviously not possible to extend this technique.

For commercializing the preparation, the paper can take the form of strips (10×3 cms.) divided into squares by thin lines. Among the advantages claimed for this preparation is the ready availability of a standard preparation, the employment of which for quantitative work is rendered extremely easy since one has only to cut out a measured area of the paper and directly put it into the test substrate.

M. SREENIVASAN.
M. SREENIVASAYA.

Indian Institute of Science,
Department of Biochemistry,
Bangalore, *August* 23, 1932.

Attempts to produce Uric Acid Calculi in Albino Rats.

IT is known that rats have a high uricolytic index, but whether there is any limiting value to the uric acid excreted in their urine is not definitely known.

An attempt was accordingly made to ascertain whether the ingestion of pure uric acid, in large amount, would appreciably increase the uric acid content of the urine. It was found that it did not do so, even when it was ingested in amounts as large as 200 mg. per rat per day. The usual explanation given of the relatively low excretion of uric acid in the urine of rats is that it is converted into allantoin by uricase. It was expected, therefore, that the high ingestion of uric acid would lead to a relatively high excretion of allantoin in the urine. No such increase in its allantoin-content was, however, observed. To facilitate a better assimilation of the ingested uric acid, sodium carbonate, in amouts necessary to form sodium urate, was administered with it. Even then, there was no appreciable increase in the uric acid, allantoin or total nitrogen-content of the urine. Subcutaneous and intravenous injections of an isotonic solution of uric acid did increase the uric acid, allantoin and total nitrogen content of the urine, but the increase in uric acid was not commensurate with the amount of uric acid ingested. The subcutaneous injection of as much as 288 mg. of uric acid raised the uric acid content of the urine by barely 6 mg. The results, so far obtained, appear to indicate that there is a definite, and relatively low, limiting value to the excretion of uric acid by the albino rat above which uric acid present in the blood stream is converted into some other product, and excreted. What this product is, is not definitely known. Phenyl-cinchonic acid is known to mobilize the uric acid in the tissues of man and to get rid of it in the urine. It was observed that when this substance was administered to rats along with uric acid subcutaneously, the excretion of uric acid was increased three-fold; this increase being associated with a greatly increased excretion of urine so that the percentage urinary excretion of uric acid remained much the same as when phenyl-cinchonic acid was not administered: a result similar to that reached by Krafka in Dalmatian dogs, whose uricolytic index is low. Prolonged feeding on glandular organs rich in purine bodies, such as spleen or liver, did not lead to any great increase in the uric acid content of the urine. These results would appear to indicate that the experimental production of uric acid calculi in albino rats is not possible.

R. MCCARRISON.
S. RANGANATHAN.

Nutritional Research Laboratories,
Coonoor, *August* 24, 1932.

On the Nuclear Spin Moment of the Tl Atom.

IN a recent note in *Nature** it was reported that the fine structures of the important arc lines of Tl could be explained if each of the two isotopes was assigned a nuclear spin moment of $\frac{1}{2}$ $(h/2\pi)$. The structure of the line 3776 ($6\,^2P_{\frac{1}{2}}$—$7\,^2S_{\frac{1}{2}}$) was studied in detail and was found to show more components than Schüler and Keyston† observed. While the value of $i=\frac{1}{2}$ was sufficient to explain the H.F.S. observed in 5351 and other arc lines, the complex structure of 3776 remained to be accounted for. Using a low current vacuum arc of an amalgam of Hg and Tl as source‡ and Quartz Lummer plate (200×30×8 mm.) and fused silica etalons, we find the line to be a group of 6 components as shown below:—

* *Nature*, October 17, 1931.

† *Zeit. fur. Physik Band*, **70**, pp. 4–10.

‡ This lamp was kindly made for the author by Prof. Venkatesachar.

3776. $6\,^2P_{\frac{1}{2}}$—$7\,^2S_{\frac{1}{2}}$	$d\lambda$	$d\nu$
	+0.064	—0.448
	+0.057	—0.399
	+0.010	—0.070
	0.000	0.000
	—0.530	+0.371
	—0.093	+0.651
	—0.101	+0.707

On account of the closeness of the satellites, the measurements made on the Lummer pattern have not been sufficiently accurate

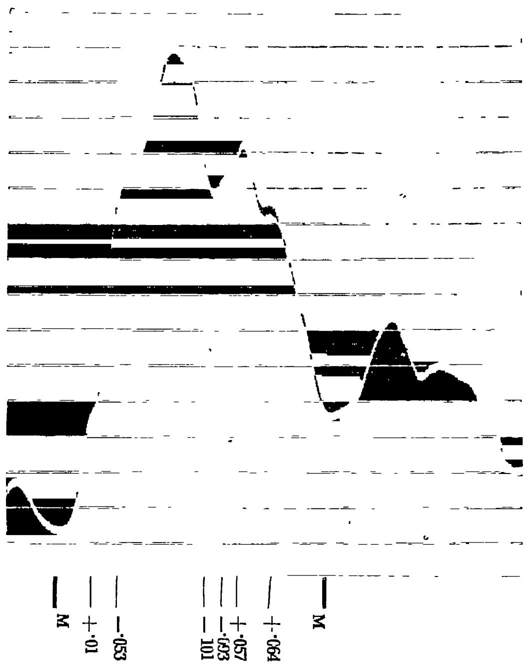

Fig. 1.

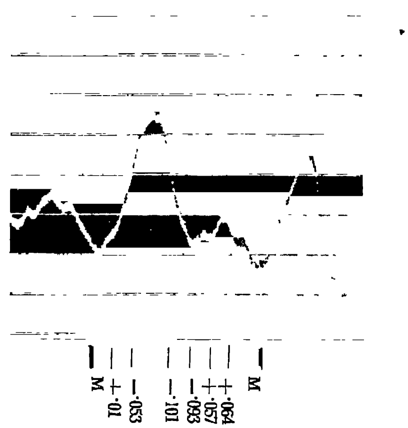

Fig. 2.

to fix the wavelength interval without ambiguity. The wavelength intervals of +0.057 and —0.101 have however been accurately determined from etalon photographs. The values assumed here for the other setellites are the weighted averages of several measures made on the Lummer patterns.

From a consideration of the distribution of the satellites indicated in the above table it is found that the complexity of structure of this line could be quantitatively explained if we supposed that $^2P_{\frac{1}{2}}$ term like the $^2P_{3/2}$ term shows an isotope displacement of about 0.050. Microphotometric traces of the Lummer pattern for 3776 for two different current values are shown in the accompanying figures 1 and 2. The diagram of structure is indicated at the bottom in each case. The observed component at —0.053 does not find a place in this scheme and it has also been observed by Wali Mohammad.* It is interesting to note from these curves that slight variations in the excitation bring about marked changes in the relative intensities of the components, a fact that has been recently noticed by Schüler and Keyston and Subbaraya and Iyengar in the case of mercury.

These observations together with those previously reported by one of the authors confirm the isotope displacement effect observed in the H. F. S. of Tl 1 lines.

A. L. NARAYAN.
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Kodaikanal Observatory,
August 20, 1932.

On the Migration of Mineral Salts from the Plant into the Soil.

TEXT-BOOKS on Botany, Plant Physiology and Agricultural Chemistry are silent on the ultimate fate of mineral matter absorbed by a plant from the soil. It appears to have been tacitly understood that the mineral constituents absorbed by a plant from the soil remain in the plant. Recent work on plant nutrition shows that there is a backward move of salts from the plant into the soil and that a portion of the mineral matter taken in flows back into the soil at least when the active life functions are over.

Wilfarth, Romer and Wimmer,† from their studies on assimilation of the elements

* *Phil. Mag.*, Vol. V, May 1928, pp. 1111–1114.
† *Landw. Versuchs-stat.*, **63**, 1, 1905.

of nutrition by barley, wheat, peas, mustard and potato at different periods of their growth in the field, were the first to suggest a back flow of minerals from the plant into the soil. Later studies by different works on similar lines supported the findings of Wilfarth and his associates. Le Clerc and Breazeale* and André† were of the view that the loss of mineral matter from the plant occurred as the result of washing from the leaves rather than from the root.

Independent evidence, which will soon be published, in support of the mineral migration hypothesis is forthcoming from the soil solution studies in the laboratories of this Institute. The concentration of the soil extract from the cropped soil is lower than that of the uncropped one during vigorous growth period of cotton crop. After this period the difference becomes gradually less and soon the concentration of the soil extract from the cropped soil becomes higher and continues to be so till the end. The migration of nutrient salts from the plant into the soil is thus evident. The plant like any other organism draws up its food requirements during the growing period, then ceases absorption and maintains itself without further appreciable indent on the soil. When the assimilation and elaboration of the absorbed material is over and the final ripening stage is reached, the surplus mineral constituents are sent back into the soil.

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September 3, 1932.

* *U.S. Dept. Agric. Year Book*, 389-402, 1908.
† *Compt. rend.*, **151**, 1378, 1910.

Research Notes.

The Structure of Atomic Nuclei.

IN *Zeitschrift fur Physik* (77, 1, 1932), W. Heisenberg considers the possibility of deducing the properties of the nuclei of different elements, particularly those of heavy elements in relation to radioactive transformations from the hypothesis that all nuclei are built up of protons and neutrons alone without any free electrons. He assumes the neutron to be a single entity which is capable of disintegrating into a proton and an electron under certain circumstances, rather than considering it as a structure made up of a proton and an electron. He finds it necessary to assume that neutrons follow the Fermi statistics and possess a spin of $\frac{1}{2} h/2\pi$ so as to explain the behaviour of the nitrogen nucleus. On the analogy of the H_2^+-ion and H_2-molecule, the forces between proton and proton, proton and neutron, and neutron and neutron are assumed to consist in an electrostatic repulsion between the protons, an attraction between proton and neutron due to an oscillatory exchange of the negative charge between them, and an attraction between two neutrons, respectively. Relativity effects are supposed to be negligible. When the sum of the kinetic energy of the particles and the energy due to the exchange of negative charge between proton and neutron alone is considered, it is found to be a minimum when the nucleus has as many protons as neutrons; thus the fact that the atomic weight is nearly twice the atomic number is explained. When the number of protons increases, the energy due to their repulsion can no longer be neglected and the ratio n_1/n_2 of the number of neutrons (n_1) to that of protons (n_2) becomes larger and larger than one as the atomic weight increases. It is also found that a nucleus containing neutrons alone will be most stable when their number is two. The Helium nucleus containing two protons and two neutrons should therefore be expected to be very stable and its total spin should be zero. Experiment fully confirms these conclusions.

The examination of the mutual forces between two nuclei leads to the conclusion that at great distances they repel each other but at small distances they become firmly bound by a kind of Van der Waals' attraction and also the attraction of the neutrons.

Assuming that the force due to the exchange of negative charge is greater than the attraction of the neutrons, it follows that a nucleus made up of neutrons only will decrease in energy content when a neutron is replaced by a proton. Hence such a nucleus will go on suffering β-transformations till the energy that becomes available by the addition of a proton exactly equals the energy required to remove the neutron. When the ratio n_1/n_2 falls below a critical value, particularly in the case of

heavy nuclei, the Coulomb repulsion between the protons outweighs the attraction of the neutrons. The nucleus then suffers an α-transformation. We expect an α-particle to be given out rather than a proton, because the protons and neutrons would be present in the nucleus in the form of α-particles on account of the extraordinary stability of the combination of two protons and two neutrons. Thus if we consider that at the head of a disintegration series there is a nucleus with an even number of protons and that it is stable with respect to a β-transformation, we should expect it to give out α-rays until n_1/n_2 exceeds the critical value. Then a β-transformation takes place leaving an odd number of protons. But if another proton takes the place of a neutron, an α-particle would be capable of being formed inside the nucleus and this should result in a diminution of the energy of the system. Hence we should expect two successive β-transformations when the initial atomic number is even. This prediction is confirmed by all three radio-active families. Thus in the Thorium series two consecutive β-transformations occur twice and in both cases n_1/n_2 has the values 1.585 and 1.55 nearly. The same thing occurs in the Radium series when n_1/n_2=1.595 and 1.57. In the Actinium series which begins with an odd atomic number there is first a single β-transformation when n_1/n_2=1 596 and then two consecutive β-transformations occur when n_1/n_2=1.62 and 1.59. However, two consecutive β-transformations occur in the Radium series for the third time and in this case n_1/n_2=1.56 and 1.53. This shows that besides the value of n_1/n_2 and the stability of the Helium nucleus other factors should also play a part in the determination of the stability of nuclei.

Disintegration of Rocks.

[By Mohammed A. R. Khan, *Begumpet, Deccan.*]

THE formation of laterite from the decay of basalt is well known; but it does not appear that much attention has been paid to the resulting of loose sandstone (or "*moram*" as it is locally called), from the decay of granites and trap-rocks, *mainly* by the action of roots of several varieties of thorny plants. Microscopic and specific gravity examinations of several rocks have shown that where the rock has been acted upon by tiny roots and plants, the felspar and hornblende have been observed to have undergone complete or partial decomposition, portions of the same rock not subjected to this action retaining their normal compactness and composition. The specific gravity of the disintegrated rock powder is always less than that of the unaltered rock powder. The "*moram*" soil of the Deccan, which is formed from the decay of granite or trap rocks, is probably mainly due to the action of plant roots. Among the plants which take a prominent part in this kind of action may be mentioned *carissa carandus*. There are several other plants also which occur more frequently and act more formidably which have not yet been identified.

Breeding for Disease Resistance at Dharwar.

[By G. L. Kottur, *Dharwar.*]

FUSARIUM wilt is a serious disease for Kumpta cotton in the whole of the Bombay Karnatak. On the Experimental Station at Dharwar it first made its appearance with Broach cotton in the year 1909 and in about twelve years time rendered the whole area unprofitable for cotton growing. To remedy the situation, selection for wilt resistance was taken up and Kumpta cotton was grown in plots known to be highly infected by the disease. Although the crop was practically wiped of, few individuals did survive to produce cotton. The seed of such plants was individually collected and tested in the same way. Following the selection we have now a large number of wilt-resistant cottons, one of which is Dharwar 2, a strain of Kumpta. This resists wilt to the extent of 90–98 per cent on highly infected plots where Kumpta suffers by 60 per cent or more. In other economic characters, specially the staple, it is, however, wanting. For this purpose the cross was made between Dharwar 2 and another pure strain of Kumpta, *viz.*, Dharwar 1. This cross has yielded a type that possesses the desirable characters of both the parents and its seed is being distributed for cultivation under the name of Jayawant. Last year it was cultivated on an area of more than a lakh acres in Dharwar, Belgaum and Bijapur districts and it resisted wilt remarkably everywhere.

X-Ray Diffraction Studies of Calculi.

[S. Ranganathan, *Pasteur Institute, Coonoor.*]

X-RAY diffraction studies were made of vesical calculi (human and cattle), of gall-stones from human beings, and of pure uric acid and cholesterol. It was found that in all the varieties of calculi examined, the substance or substances constituting them were deposited in the crystalline state, though a little variation in the order of magnitude of the crystals was observed. Uric acid in human calculi and calcium carbonate in cattle calculi were definitely shown to exist in the crystalline state. Gall-stones presented several interesting phenomena, chief of which were the occurrence of intensity maxima arcs due to the orientation of the crystals in certain preferential directions, and the contraction of the rings due to the extremely fine state of division of the cholesterol crystals. An explanation has been offered, in the light of the X-Ray analysis, for the existence of the pigmented and the non-pigmented varieties of gall-stones.

The Effect of Temperature on the Leg Posture and Speed of Creeping in the Ant Lasius.

IN a paper in the *Biological Bulletin* (62, No. 3, 1932), T. Cunliffe Barnes and Henry I. Kohn describe an attempt to investigate the influence of temperature upon the locomotion of ants *Lasius niger* and *Lasius umbratus*.

The ants were allowed to crawl over smoked kymograph paper, and the trails made by the metathoracic legs were photographed, the experiments being conducted under different temperatures. It was discovered that the leg-spread factor increased with the rise of temperature.

To calculate the speed, the ants were allowed to crawl in a glass tube, both the ends being closed with moist cotton. Using certain equations, graphs are drawn and it is also proved that the speed of progression in *L. niger* shows a critical temperature at 20° and yields two values for μ; 10,700 between 16°–20° and 22,900 between 20°–25°.

On Plasmodicid Action of Atebrin.

EXPERIMENTS conducted in Dr. Mello's laboratory and the Hospital in Nova Goa in collaboration with Dr. L. J. Eras de Sa and Antonio d'Azevedo have shown: that Atebrin (known also as *Erion*), a synthetic drug whose composition will be known this year, has a destructive effect in all forms of *Pl. vivax* and *malariæ* and on Schizonts of *Pl. falciparum.* The gamets of this last species remain unaltered. Clinically, the fever comes to normal in 24 hours to 4 days. Acute splenomegalies respond also quickly to this treatment. Atebrin seems, if not superior, at least equal to quinine in checking malaria, and its combination with Plasmoquine will be a very useful means for the sanitation of malarious countries (full report not yet published).

Circulation of Blood in the Air-Breathing Chambers of Ophiocephalus Punctatus.

IN the last number of the *Journal of the Linnean Society of London* (Vol. **38**, No. 257, 1932) S. H. Lele makes a brief reference to the habits of the Ophiocephalid fishes and gives an account of the form, position and associated structures of the air-breathing chambers of *Ophiocephalus punctatus* Bloch. Attention is directed to the highly vascular nature of the relatively thin and so-called "practically non-vascular" membrane lining the roof of the air-chambers. As regards circulation it is indicated that the first and second bronchial arteries after giving small branches to the gills are continued as large vessels to supply blood to the air-chambers. The capillaries of the air-chambers drain into the tributaries of the anterior jugular vein. Special attention is directed to the fact that the oxygenated blood gets mixed up with the venous blood. The third and fourth afferent arteries after giving small branches to the gill-filaments are continued as large vessels to join the suprabranchial of their side. In this way the blood passes through them directly to the arterial system without oxygenation in the branchial filaments of the gills. From these observations Mr. Lele suggests that this defective circulation may have induced the evolution of the four-chambered heart of the higher vertebrates from the two chambered heart of fishes.

Carpel Dehiscence in Firmiana Simplex.

[Tsu-Kiang Yen, *Bot. Gaz.*, **93**, No. 2, 1932.]

THE follicle of Firmiana simplex (L) W. P. Wight, is of interest in that in early stages of its development the carpel edges are distinct and separate, later they are

firmly united and still later they are again widely separated. The material was collected at the National Central University, Nanking, China, and was investigated at the Hull Botanical Laboratory, University of Chicago. The coalescence of the two rims of a single carpel is by means of close approximation, cell division and cell-enlargement. Development of additional sutural tissue is brought about by the activity of the cells at either margins of the carpel, which meet and then divide tangentially to the suture. The two placental bundles are partly responsible for the fusion of the carpel margins. Coalescence of the stylar region takes place before pollination and later entire style withers and is broken off. Carpels open by mechanical breaking, thus rupturing the individual cells. The coalescence of carpels is ephemeral and exists only during the period of pollination as if the five distinct carpels are joined throughout their common stylar region. This may indicate also that the pistil is an intermediate stage between the apocarpous and the syncarpous conditions.

On Some Nematode Parasites of Goats and Sheep at Muktesar.

By G. D. Bhalerao,

Helminthologist, Imperial Institute of Veterinary Research, Muktesar.

THE goats and sheep that are used for experimental work at Muktesar appear to be very rich in their parasitic fauna which presents very interesting features. An investigation into these has been in progress for over a year and a detailed account of the different interesting parasites and the part they play in the economy of their hosts, is in the process of publication. The parasites were collected from four kinds of animals: Hill and Tibetan goats (*Capra sibirica*), hill sheep (*Ovis nahura*) and Tibetan sheep (*Ovis hodgsoni*). All these animals were used for maintaining the Rinderpest virus at this Institute.

The entire collection consists of several worms but it is not intended to refer here to them all. The remarks will be limited to such parasites only as are altogether new to science or to those that have not been recorded from India upto the present time. In one case are given some interesting variations in the structure of a very common parasite which, in spite of their frequent occurrence, are altogether unknown.

A nematode belonging to a new genus of the family Metastrongylidæ (and a new species), *Varestrongylus pneumonicus*, gen. et sp. nov. was discovered in the bronchi of the goats and sheep. This parasite is very interesting from the zoological standpoint in that the females possess a valve covering the vulva and the anus is situated at the posterior end, features hitherto unknown among the members of the family Metastrongylidæ. The males also possess many interesting features particularly in regard to the genital bursa, the spicules and some chitinous structures connected with them.

Besides the morphological interest of the parasites they have a very great economic value, since they were found in all animals which had died of broncho-pneumonia. The worms being present in the bronchi bring about the asphixiation of the animals. In the post-mortem examination, the bronchi are found filled with a frothy secretion. They also possess a very great capacity for laying eggs which fill up almost completley the whole of the lung tissue and bring about its congestion.

Experiments to evolve a successful treatment of this abominable scourge of these animals are in progress. Some of the drugs recommended strongly by some American and German authorities met with no success in this country.

A new species of worm, *Dictyocaulus uniqualis*, was found in the bronchi of a Tibetan sheep. The males of this species have a structure somewhat different from *D. filaria*, particularly in regard to the bursal rays. The animal from which this parasite was recovered had also died of broncho-pneumonia.

Two parasites of the family strongylidæ, *œsophagostomum venulosum* and *O. asperum* from the cæcum of hill goats have been obtained for the first time in India.

A new parasite, *Ostertagia orientalis*, has been discovered from the cæcum and abomasum of hill goats. This species appears to be somewhat less common than the species *O. circumcincta* which is found in almost 60 per cent of the goats at Muktesar. It is rather surprising to find that there exists no previous record of the occurrence of the latter species in spite of its very large incidence. This may, presumably, be due to the fact that these worms produce no pathological symptoms and for this reason their presence may have so far remained unnoticed. Only one male specimen of the species *O. occidentalis* was obtained from the cæcum of hill goats.

The species *Hæmonchus contortus* found so commonly among the goats and occasionally in the abomasum of cattle presents very interesting variations in regard to the structure or structures developed in the vicinity of the vulva. In all the text-books on helminthology this species is described to possess a well-developed linguiform process or flap overhanging the vulva, but the specimens at Muktesar exhibit various gradations of the development of this flap and in some cases it may be bi-lobed resembling the head of a bird. Occasionally, one or more cuticular bosses may be developed in the neighbourhood of the vulva and specimens are not wanting in which are developed neither the bosses nor the flap.

The Industrial Outlook.

Ceramics.

B. K. Ramprasad.

A FACTORY for the manufacture of porcelain insulators for electrical purposes and ordinary crockery on a small scale has been started by the Government of Mysore, in Bangalore. It is learnt that the first batch of insulators have been successfully fired and have passed the electrical and mechanical tests satisfactorily. The Hydro-Electric Department of the Mysore Government and the Department of Industries and Commerce have carefully surveyed the requirements of the local electrical supply schemes and others in Southern India and it is expected that the Factory will be able to meet the demands satisfactorily so far as insulators up to 13,000 volts are concerned. This is just the beginning, and much development and research work is to be done hereafter to utilize the local raw materials to the best advantage and also modify the processes accordingly. At present, an intermittent coal fired furnace is being used for the different stages in firing, but the utilization of electric heat by means of a suitable kiln will have to be adopted, as sufficient power at reasonable rates is available in Bangalore, and coal has to be imported either from Bengal or abroad.

Intensive research from the point of view of the physics and chemistry of Ceramics is to be carried out with the available raw materials in order to meet the rigorous demands of electrical porcelain: high voltage research on the porcelain products is also necessary to keep up the quality. It is lucky that the Factory is located near the Indian Institute of Science and it is hoped that the various problems of Ceramics in general and of the Porcelain Factory in particular will be taken up for investigation in these laboratories.

* * *

USE of the new protective material known as "Thiokol" for electrical purposes has been taken up by the General Cable Corporation under a licensing agreement with Thiokol Corporation. Extensive tests over a two-year period have demonstrated that a jacket of proper Thiokol compound over rubber is superior to the rubber itself in resistance to chemical action, fatigue, sunlight, oil, vibration and corona. It also has advantages as cable sheathing. Development work is already in progress to complete the adaptation of the new material to power cables, overhead conductors and secondary net-work conductors. It will also be employed for wire pertaining to general industrial uses where rubber is subjected to the deleterious influence of oil, acid, weather or light. The field at this time is limited to 600 volts. (*Electrical World*, July 16, 1932.)

* * *

The latest of the contributions of electrically deposited metals to the advancement of industry is the use of chromium plated steel. Mill rolls, roller leveller rolls and cold finishing rolls are notable uses. In the case of the former it is possible to substitute ordinary forged steel (0.70 to 0.80% carbon) for tool steel and it is said that by having a well grounded finish on the roll before chrome plating, a much higher finish can be offered than with a tool steel roll. Because of the extreme hardness of chromium these plated leveller rolls remain in service over a long period of time often outlasting a tool steel roll for 4 to 6 regrinding periods. When the plated leveller rolls finally indicate some wearing through of the chromium plate, provided the underlying steel has not been marred, the plating can be stripped and again chromium plated without regrinding. The cost of such plating is said to be relatively inexpensive considering the initial cost of the rolls. (*Electrical World*, July 23, 1932.)

* * *

An X-ray machine that can take snapshots and that will be able to photograph moving internal organs of the body has been developed and is now being tested by the New York Hospital—Cornell Medical Centre. It takes pictures about 20 times faster than the ordinary radiograph and will be able, because of the increased amount of light that can be used, to photograph clearly such soft tissues as incipient ulcers, ruptures of the muscles and cancerous growths. Research workers and technicians of the General Electrical Company worked in collaboration with Dr. John R. Carty, Radiologist of the New York Hospital and Associate Professor of Radiology at Cornell University Medical College, to perfect it. (*Electrical World*, July 23, 1932.)

A New Process for Wood-Preservation.

[R. Falk and S. Kamesam, *Ind. Pat.*, 18580 of 1932.]

THE invention is based on the observation that when mixtures containing arsenic compounds and chromium salts in aqueous solutions are used for impregnating wood, neither of the two components get washed out within a certain range (As_2O_5 : $K_2Cr_2O_7$ =1:1.25 to 1:1.75) while at others either the arsenic or the chromium salt passes out quite readily. A preservative containing both within the optimum range is very efficient against wood-destroying fungi and insects and can be applied by injection in closed vessels or dipping in the open or painting with the solution. It can also be combined with other insecticides and fungicides or fire-proofing chemicals, provided the latter are present in small proportion, generally, less than 20 per cent.

A Preservative for Fruits and other Organic Bodies.

[P. Worthington and H. C. Webb, *Ind. Pat.*, 18108 of 1932.]

THE invention relates to the application of monovalent alkali salts of ichthyosulphonic acid (chiefly the ammonium salt termed ichthyol), to the preservation of fruit, particularly those of the citrus type, apples and tomatoes. The preservative, which renders the fruit highly resistant to fungus attack is best applied by dipping, spraying or brushing after admixture with a suitable carrier like petroleum jelly, glycerin, gelatin or vegetable gum. It is stated that the preservative does not detract from the edibility of the fruit as it is not substantially absorbed in the human alimentary system.

Science News.

SCIENTISTS in India will be gratified to read that Lt.-Col. R. B. Seymour Sewell, I.M.S., Director, Zoological Survey of India, has been requested to accept the post of Leader of an Oceanographical Expedition to the Arabian Sea. The Expedition is being sent out by the Cambridge University to investigate the area in the Arabian Sea from the Persian Gulf down to about the level of Madagascar and from east to west between India and Africa. The investigation will be specially carried out in reference to the zonation of the fauna on the continental slopes of the two sides between 50 and 1,000 fathoms, and the problem of the bottom deposits will also receive special attention. The Expedition will, as a result of its researches, be able to throw a definite light on the hypothetical Lemurian connection between Peninsular India and South Africa in the Palæozoic and earlier Mesozoic times.

* * *

The Muslim Association for the Advancement of Science was inaugurated at Aligarh in the early part of 1931, with the object of stimulating the spirit of original investigation amongst Mussalmans and of providing closer co-operation between Moslem scientists in different parts of India and elsewhere. The Association also undertakes the publication of *Proceedings*, somewhat on the lines of "*Chemical Reviews*", published by the American Chemical Society, containing summaries in specialized scientific fields by investigators who are engaged in active research work in these branches. The first volume of these *Proceedings*, which was published in December 1931, contained a long memoir by Professor R. F. Hunter on the work of his collaborators in the Thiazole Group during the last six or seven years.

The office-bearers of the Association are as follows: *President*, Nawab Masood Jung Bahadur, B.A., LL.D., Vice-Chancellor of the Muslim University; *Vice-Presidents*, Professors R. F. Hunter, D.Sc., Ph.D., D.I.C., and H. W. Blood Ryan, M.A., D.Sc., Ph.D., LL.D.; *Secretary*, Dr. M. Baber Mirza; *Council Members*, Drs. Syed Husain, A. A. Hyder, Rafique Ahmed, S. D. Muzaffer, S. Siddiqui, Professors Abdul Rahman Khan, R. Samuel and Mr. M. Haider Khan.

* * *

A few bronze medallions, struck by the South Indian Science Association, Bangalore, in commemoration of the Nobel Prize award to Sir C. V. Raman, are available from the Secretary at rupees two each.

* * *

Addressing the South Indian Science Association on the 19th August 1932, on "The Technique of Talkies", Dr. Lal C. Verman traced the development of the industry from the days of Edison's first crude attempt in 1913 to the modern talkie film. The essential principles of reproducing sound by the "sound on disc" and "sound on film" methods were described and the future lines of the development of this immensely popular and growing form of entertainment were outlined.

* * *

In a paper on "The Biological Values of Proteins from some Indian Food-stuffs", presented before the Society of Biological Chemists (India), on August 1932, Mr. N. Narayana explained the term Biological Value as defined by Thomas and later by Mitchell. After conducting experiments on rats with proteins from some ten Indian pulses, he found that their biological value varied from 57 to 78, while their digestibility varied from 58 to 83. *Cicer*

arietinum showed the highest biological value closely followed by Tuar dhal. On calculating from the figures for digestibility and biological value, the net protein value of these pulses was found to range from 10.43 per cent for *Dolichos biflorus* to 16.68 per cent for *Cicer arietinum*. On an average only about 50 to 60 per cent of the total protein of these pulses are available for the building up and repair of tissues in the body. There are serious limitations to the method of experiment for which possible remedies were suggested.

* * *

In a lecture entitled "Vegetable Ghee", Mr. P. Ramaswami Ayyar told the South Indian Association the essential factors of fats as food materials. His analysis of a large number of fats and oils and also attempts to synthesise vegetable ghee by hydrogenation led him to conclude that the "vegetable ghee" availabe in the market was, generally, a very poor substitute to genuine ghee and lacked in many essential nutritive factors, although a few kinds existed which nearly came up to the mark. Good oil was a better substitute than ghee when considered from the point of food value and nutrition. But taste comes in and so oil has its limitations. It should be possible to make a good vegetable ghee by mixing the correct quantity of oil, fatty acids and vitamin concentrates.

* * *

We have received a copy of Vol. I of the Bulletin of the Academy of Science of the United Provinces of Agra and Oudh, Allahabad. The Bulletin contains original papers in mathematics, physics, chemistry, botany and zoology, contributed by the members of the Academy, chiefly from the United Provinces. Full reports of the inaugural meeting when addresses were delivered by His Excellency Sir Malcolm Hailey, the Patron, and Dr. M. N. Saha, the President of the Academy, are also included at the end. There is a very interesting summary of Sir C. V. Raman's lecture on the Spin of Light delivered at the First Annual Meeting of the Academy. We welcome this interesting publication and hope that the Academy will continue to keep up its activities in the same high level as is shown in its first publication.

* * *

The University of Calcutta held an academic reception to Dr. Rabindranath Tagore on 6th August 1932, when Sir Hasan Suhrawardy, the Vice-Chancellor, welcomed the poet as "perhaps the most brilliant of the few persons who have made the culture of modern India understood and appreciated by the world at large". In a very touching reply Dr. Tagore said, "If in spite of my being a misfit, any connection has been established between me and our University, I feel I stand here on the side of the students to tell those who are young, that the strenuous course of their study and pride in their acquisition must never harden all that is delicate and living in their nature. their power of faith, of simple joy, and of sensitiveness to subtle touches of existence. It is fortunate to be able to acquire knowledge, but it is a rare privilege to be able to accept life in its varied significance, with unabated sympathy and interest untouched by cynicism and the coarse pride of cleverness."

* * *

Addressing the Annual Convocation of the Bombay University on the 16th August 1932, Sir C. V. Raman defined true scholarship as contrasted with scholasticism. He claimed science as a panacea for all ills–political, economic, communal, moral and spiritual. In a trenchant criticism of Indian Universities, he pleaded for an abolition of the present scholasticism practised by them and suggested a revolution in our educational outlook wherein the human spirit, intellect, and genius would manifest themselves at their highest.

* * *

A report in the *Hindu* says that the Cosmic Ray Expedition, which has been formed to study the Sun's rays at very high altitudes, comprising of Professor J. M. Benade (organizer and leader), Mr. Ross Wilson of the Foreman College Staff (Lahore) and Mr. R. K. Sharma, of the Ewing College Physics Department, which left Allahabad and Lahore last month, have reached Kulu, the first stage of the journey. The objective of the expedition is the high barren ridge near the shores of Tso Morari, a large brackish lake lying north-east of the Spiti valley and south-east of Lah and at an elevation of 15,000 feet above the sea-level.

From Karzok, a village on the western shores of Tso Morari, the expedition will attempt to reach an elevation of at least 20,000 feet, from which to make observations of the intensity of the Sun's rays. Originally, it appeared that the ridge of the west, with at least two peaks of over 20,000 feet, would best meet the conditions under which the observations are to be made, but information recently acquired at Kyelang from travellers who have visited the region of Tso Morari, gives reason to believe that the eastern ridge, with twin peaks of over 21,000 feet, will afford even better facilities.

The first stage of the journey to Manali in Kulu valley, the centre of the extensive fruit-growing industry of that valley, was accomplished by motor-lorry. From Manali, the expedition set out on foot with a train of 21 ponies, laden with the requisite scientific apparatus and supplies for six or seven weeks through little known country. Crossing Rotang Pass into Lahoul, the party set out on the most difficult part of its journey. They hope to reach Karzok shortly.

* * *

The Hon'ble Dewan Bahadur S. K. Reddiar's address delivered at the Madras Convocation is, as is usual on such occasions, full of mighty utterances. However, his conception of the requirements of representative Government and the adaptation of the educational system to meet them, is certainly original and we are reminded of the classification of mankind by Charles Lamb and later by Matthew Arnold. The educational system should be designed to produce three classes of peeple:—

(1) A wide Electorate hailing from the Elementary Schools.
(2) Representatives of the people in the legislatures produced by the Secondary Schools.
(3) A very small body of leaders who will be the creation of the Universities.

We have no doubt that there is great hope for Education in the reformed Constitution.

* * *

Prof. D. B. Blacklock, M.D., Professor of Parasitology, University of Liverpool, has put forward a very strong plea in the *British Medical Journal* for June 18, 1932, for the inclusion of Parasitology in the medical curriculum. Discussing the aim of the authorities responsible for the medical curricula, the author considers that the medical curriculum cannot be regarded as an exercise merely for the training of the mind without any idea of the immediate or future utility in reference to the training of medical graduates. The study of Parasitology, as he rightly points out, plays a very important part in the post-graduate experience of every medical practitioner, and the sooner he obtains an insight into realities of the existence of such parasites, the better equipped will he be to deal with those pathogenic organisms which are responsible for so many diseases man. After enumerating the pathogenic parasites of man, belonging to the phylum Protozoa, Platyhelminthes and Nemathelminthes, the writer considers that utility should be the chief and almost the sole criterion of the value of the education given to the medical graduates. He very pertinently suggests that the question which a teacher of medical education in any branch should ask himself should be " 'How much of my subject will prove of real practical value to the student at any time?' not 'How much of my particular subject can I cram into this fellow in a given time?' " and he rightly concludes that the introduction of elementary Parasitology in the curriculum for the earlier years in the medical students' career would prove extremely useful. The knowledge that the students are studying something useful for their after-life will be a definite attraction, while the complicated and diverse life-histories of the human parasites would stimulate the imagination of the students and develop powers of observation and reasoning to such an extent as to give them a vital interest in the study of Zoology. We believe that the authorities responsible for the medical education in different places in India would do well to study Prof. Blacklock's article and adopt the major part of his suggestions.

B. P.

Reviews.

The Life Line of the Thyroid Gland. By Col. R. McCarrison and Prof. K. B. Madhava. Thacker Spink & Co., Calcutta, 1932.

The problem of the causation of the enlargement of the thyroid gland, which we call 'goitre', is one of the most difficult as well as one of the most fascinating in the whole range of Medical Research. Since the time of Hippocrates theory has followed theory in attempts to explain it. Yet, strange as it may seem, there has hitherto been little attempt to define the normal limits of the thyroid gland's size. It is true that figures purporting to represent the normal weight of the organ in different races are to be found in text-books and monographs dealing with disorders of the gland, but these are not, as a rule, expressed in terms relative to some other readily obtainable body measurement; so when we are told that the normal weight of the gland lies between 20 and 60 grammes in man, and rather more in women, we are at a loss to know whether a gland weighing, say, 60 grammes in a person of 16 stone would be within normal limits were it to be found in a person weighing ten. Furthermore, we derive the impression that the organ is normally larger in females than in males; an impression which may require some qualification. A few observers have given the normal weight of the gland in terms of body-weight: Marine, for instance, has stated that the upper limit of the normal weight is 0.35 gm. per kilogramme of body-weight. But such an estimate, though it may possibly be accurate enough at one period of life, does not allow for the possibility that it may vary at different periods and under different conditions of life and yet be normal. In short, the question, "What is the normal size of the thyroid gland?", is one that calls for answer as urgently as does the other one, "What is the cause of the thyroid gland's enlargement?" Indeed, it is impossible accurately to answer the latter until an accurate answer to the former has been given. R. McCarrison and K. B. Madhava have in their recently published *Memoir*, "The Life Line of the Thyroid Gland", attempted to answer both these questions. In this attempt they have brought the biometric to the aid of the experimental method of investigation; a combination which is a happy one.

Colonel McCarrison, whose researches on 'Goitre' are well known to all students of this subject, has provided the extensive experimental data which his colleague, Professor Madhava, has subjected to the closest statistical scrutiny, with results which throw a flood of light on many dark places in the ætiology of Goitre. The biometric method has provided a ready means of determining the normal size of the thyroid gland and the normal range of its variation in size; and of estimating with accuracy the degree of its departure

from normal and the effect of agencies which cause it to increase or to diminish in size to an abnormal extent. This method of detecting departures from the normal size of the gland has a greater precision than the histological study of the gland itself; for in its detailed structure the organ normally varies within the widest limits, and without an accurate knowledge of the gland's normal range of variation in size, extremes of histological variation may lead to the description of normal conditions as pathological. Precise means of estimating the gland's size are thus an essential adjunct to the histological study of an organ which at one time may be empty of colloid and at another filled with it, depending on the needs of the body for thyro-globulin.

The authors have used data provided by different species of animals—rats, guinea-pigs, rabbits, monkeys and pigeons—living under strictly controlled experimental conditions; and the similarity of their findings in the several species of the lower animals affords reasonable grounds for the assumption that these findings are, in general, applicable to man—the more so as the physiological attributes of this remarkable organ are the same in all vertebrates.

It is impossible in the space at our disposal to do more than refer to the more outstanding of the conclusions drawn by the authors of this *Memoir*. They have shown that in early life, before the attainment of the individual to sexual maturity, the thyroid gland normally grows at a greater rate than the body as a whole. It attains to its maximum weight relative to that of the body just prior to the period which corresponds in animals to puberty in man; thereafter its relative-size gradually diminishes in both sexes, remaining at a relatively low level in males but exhibiting in females secondary rises associated with reproductive activity. The organ thus follows—from the point of view of size—a definite course throughout life. This course the authors have designated, "The Life Line of the Thyroid Gland", and they have employed this designation as the title of their *Memoir*. They point out that because of the gland's conspicuous position in the neck its relatively larger size in childhood may be mistaken for 'goitre' when, in the vast majority of children, it may be nothing more than the normal expression of the organ's place in the bodily economy. In support of this assertion the results of 'goitre-surveys' in school-children are contrasted with similar surveys in animals that have lived under strictly controlled conditions in the laboratory, and the size of whose thyroids have been acucrately determined after death while at the same time the histological changes associated with abnormal increase in size of the organ have been determined microscopically. They indicate the statistical criteria on which the gland's departure from normal size may be gauged; they discuss the influence of such factors as season, sex, sexual activity, sanitary condition and diet on the life-line of the organ, and the relationship of iodine to it—indicating the importance of this element as an antigoitrogenic agent while at the same time defining its limitations so far as their data permit them to do so. An interesting chapter is that devoted to the statistical scrutiny of the results of certain surveys of goitre in school-children; there it is made clear that without such scrutiny and without reliable criteria for the detection of departures from a normal size, erroneous conclusions may be drawn. Finally, they classify the known goitrogenic agents into two groups: dietetic and hygienic. In the former group they include excesses of certain substances in the diet—fats, fatty acids and lime, deficiencies of certain substances in the diet—vitamin A, vitamin C, iodine and phosphates, and the presence of certain goitre-producing substances of an unknown nature in some food materials, such as cabbage, some cereal grains and ground-nuts. In the latter group they include insanitary conditions of life and, by inference, infection. It is of great interest to note that insanitary condition even of a gross kind does not cause goitre unless the food be ill-constituted; the dietetic factor combining with the unhygienic induces the maximum goitrogenic action. Obviously, the 'causation of goitre' is not merely a question of deficient intake of iodine but involves factors which bring about a relative deficiency of this element—so important in thyroid function—and others that are unrelated to deficiency of iodine, either of an absolute or of a relative kind; the latter appear to be related to impairment of the gland's functional capacity rendering it susceptible to attack by unknown agents, probably toxic or microbic; and, presumably also, impairing its ability to deal with the iodine that is ingested and absorbed into the system.

No doubt the authors would themselves agree that this work does not tell the whole story either of the gland's normal activities so far as size is concerned, nor of the factors which cause it to depart from a normal size; but as an attempt to introduce order into the chaos which surrounds the subject of goitre, this *Memoir* is a notable achievement and an important contribution to Biometric as well as to Medical Science.

* * *

In a small pamphlet received by the last mail, Lt.-Col. J. Stephenson gives '*A Short Historical Survey of the Annals and Magazine of Natural History from* 1828 *to* 1932.' This historical sketch of one of the foremost zoological journals is of special interest, for it directs our attention to its chequered career since its inception in May 1828, to the illustrious contributors to its pages and to the great and noble rôle it has played in the development of human thought and in the dissemination of knowledge concerning Natural History subjects. The scope of the *Annals* was very wide in the beginning as it included Zoology, Botany, Mineralogy and Meteorology, but soon after 1878 the journal came to consist, as at present, of Zoology and Palæontology. In later years when the scope of Zoology became wider and specialization became necessary for the different branches of this science, other journals sprang up so that the scope of the *Annals* came to be largely restricted to Systematic Zoology (including Palæontology). Systematic Zoology forms the bed-rock on which all other zoological research ultimately rests, and the *Annals* in its present rôle is a storehouse of this essential knowledge. It is gratifying, therefore, that the Publishers, Messers. Taylor and Francis, Red Lion Court, Fleet Street, London, E. C. 4, are now offering a limited number of complete sets of *The Annals and Magazine of Natural History* (1838-1931) in 188 volumes at a special price of £210 net.

S. L. H.

Coming Events.

Twentieth Indian Science Congress.

The Twentieth Annual Meeting of the Indian Science Congress will be held in Patna from January 2nd to 7th, 1933.

His Excellency Sir James David Sifton, K.C.I.E., C.S.I., C.I.E., B.A., I.C.S., Governor of Behar and Orissa, has consented to be Patron of the Meeting.

OFFICERS OF THE TWENTIETH CONGRESS.

President:

Dr. L. L. Fermor, O.B.E., D.Sc. (London), A.R.S.M., F.G.S., M.Inst.M.M., F.A.S.B., Director, Geological Survey of India, Indian Museum, *Calcutta.*

Sectional Presidents:

1. AGRICULTURE.—M. Afzal Husain, Esq., M.A. (Cantab.), M.Sc., I.A.S., Locust Research Entomologist to the Government of the Punjab, The Punjab Agricultural College, *Lyallpur, Punjab.*
2. MATHEMATICS AND PHYSICS.—Dr. A. L. Narayan, M.A., D.Sc., Meteorologist, *Kodaikanal, South India.*
3. CHEMISTRY.—Dr. Panchanan Neogi, M.A., Ph.D., I.E.S., Professor of Chemistry, Presidency College, *Calcutta.*
4. ZOOLOGY.—R. Gopala Aiyar, Esq., M.A., M.Sc., Additional Professor of Zoology, Presidency College, and Honorary Director, Madras University Zoological Laboratory, Presidency College, *Madras.*
5. BOTANY.—Dr. S. L. Ghose, M.Sc., Ph.D., F.L.S., Department of Botany, Government College, *Lahore,*
6. GEOLOGY.—Prof. N. P. Gandhi, M.A., B.Sc., A.R.S.M., A.I.M.M., F.G.S., D.I.C., Professor of Mining and Metallurgy, Engineering College, Hindu University, *Benares.*
7. MEDICAL AND VETERINARY RESEARCH.—Lt.-Col. A. D. Stewart, M.B., D.P.H., D.T.M. & H., F.R.C.S.E., I.M.S., Director, All-India Institute of Hygiene and Public Health, *Calcutta*, and Professor of Hygiene, Calcutta School of Tropical Medicine and Hygiene, 21, Chittaranjan Avenue, *Calcutta.*
8. ANTHROPOLOGY.—Dr. Panchanan Mitra, M.A., Ph.D., Professor of Anthropology, Calcutta University, *Calcutta.*
9. PSYCHOLOGY.—Dr. Girindrasekhara Bose, M.D., University College of Science and Technology, 92, Upper Circular Road, *Calcutta.*

The Local Secretaries will be Dr. K. S. Caldwell, M.A., B.Sc., Ph.D., F.I.C., F.C.S., I.E.S., Principal, Science College, *Patna*, and Prof. Kamta Prashad, B.A., I.E.S., Professor of Physics, Science College, *Patna*, to whom all enquiries as to accommodation should be addressed.

* * *

South Indian Science Association, Bangalore.

(CHEMISTRY LECTURE THEATRE,
CENTRAL COLLEGE.)

Friday, 21st October, 1932, at 6-30 P.M.

'Liquid Air', by Mr. G. Gundu Rao, Indian Institute of Science, Bangalore,

our'

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CONTENTS

N.B.—Contributors and Advertisers—please see notice on the inside cover of back page.

A Ten-Year Plan for India.

In our editorial for the July number of *Current Science*, we indicated in broad outlines the main principles of a new educational policy which in our judgment is urgently called for and we described this policy as a Ten-Year Educational Plan. On 7th. September, the Associated special service announced in the press that a prominent Bombay businessman, Mr. Madhavji Govindji, speaking at a meeting held in connection with the Swadeshi Week, put forth a plea for calling "a conference of fifty Indian statesmen, an equal number of prominent Indian industrialists and as many scientists and experts for chalking out a Ten-Year Plan for India on the basis of the Five-Year Plan of Soviet Russia." He is further reported to have urged that, "the object of such a conference should be to formulate and work out a plan which would make the country economically free and self-sufficient within ten years", and that such a conference was "quite feasible and practicable". We are gratified that the project which we originally announced for the purpose of achieving certain definite results in the progress of education within a specific period, is receiving public attention. Indeed at the time we wrote about the educational plan, we were convinced that unilateral progress of a single department of public activity, would lead the country nowhere and that the time cannot be far off when it will be necessary to embark simultaneously upon a number of carefully considered projects of public utility, each having its own programme of action and achievement. In a series of articles, of which the present is intended to be a general survey, we propose to elaborate the details of some of the schemes which it is hoped will receive the due consideration of the Government and the people alike. Further in the formulation of any plan or programme which may have for its object the creation of a new and higher destiny for India, it must be borne in mind that a cheerful and sustained co-operation of the authorities and the leaders of public opinion, is absolutely indispensable. To a great extent the limitations imposed on such enterprises by the inadequacy of finance may be overcome by the initiative, organization and unremitting exertions of the people, but the most carefully thought out

plans, even if well-financed, will fail to achieve their purpose, if the country as a whole is not in a state of preparedness to receive and act on them.

Candidly we are not envisaging a Utopia. It is not maintained for a moment, nor even hoped, that within ten years, even if it were possible for all the projects to be worked simultaneously, with any degree of thoroughness and persistence, a complete transformation would be wrought in the economic, social, industrial and cultural life of this great sub-continent. It may not be extravagant, however, to suggest that under the continued stimulus of education and example, a large section of the Indian population towards the end of the period should be able to acquire sufficient initiative and enterprise to be able to work well, to eat well, to clothe themselves well and to occupy their leisure well. To a large extent, therefore, the ten-year plan, according to us, will be in the nature of exploratory work and in securing and organizing all the available resources for ensuring further progress in orderly and natural sequence. Both the Government and the leaders of public opinion may be asked the question, "What do you propose to achieve by pursuing the measures which you have respectively adopted?" The answer, "Peace and Order" on the part of one and, "Political Freedom" on the part of the other, must be imperfect to a degree, for neither can be regarded as an end in itself. Each is only a means for higher ends. Have the authorities and the peoples' representatives any programme of national reconstruction which they intend to carry out after securing the means which they have set their hearts to compass? It seems to us that they, having caught hold of the wrong end of the plough, are guiding its share along barren furrows for a crop of dead sea fruit and India would be a perfect paradise to live in if they both, who profess sympathy for the people, were to pool their resources and work in mutual trust and harmony for the advancement of the country. The idea of a ten-year plan for India may be a modification of the Soviet programme, but the schemes we have in view differ both in their object and in the methods by which it is to be attained. In referring to the tyranny of the machine, Sir Alfred Ewing in the concluding portion of his presidential address to the British Association which recently met at York, is reported to have said the following in connection with the Russian Plan, "The Comm... lays down dates for the delivery of specific quantities by each factory and invests twenty-one special directors with extraordinary powers to increase production, threatening each director with personal punishment if deliveries are belated." The construction of the Dnieper dam and the hydraulic works which formed part of the Soviet Five-Year Plan, must have proceeded on the same method of enforcing labour under threats of personal punishment; but it must be obvious that any plan whose beneficence may be as wide as humanity itself, is bound to collapse the moment the external pressure, which is its motive, is withdrawn. Coercion of labour even in the name of the peoples' emancipation must in every respect be opposed to political ethics and must be a negation of personal freedom for the attainment of which all constitutional agitation is directed.

Our ten-year plan is intended to implant in the mind of the people the recognition of work as joy and virtue and the sense that spontaneity in co-operative endeavour for their economic uplift and the higher standards of civic life, is the essence of a dignified national existence. The urgency and magnitude of the task involved in carrying out any programme of social reconstruction calculated for the betterment of the people ought to be sufficient inducement for the restoration of normal conditions of public life in the country. The genius and the vast resources of the Government and the people, without being further permitted to expend themselves in a game of out-manœuvring each other, should be unreservedly devoted to the promotion of those schemes which would lead to the evolution of a higher civilization, a thing of which India is still capable. It is true that during the past century India has achieved greatness and it must be gratefully acknowledged that such progress in education and other departments of public utility as has already occurred, is due mainly to the efforts of Government. But the tardiness of the process of development must be due to a variety of causes, among which the most potent are the limitations of finance and the unpreparedness of the country. It is the purpose of the plan to be suggested by us, to remove these major obstacles and clear the ground for continued and concerted action for the achievement of definite results in national welfare. In this process the people

ought to realize that their higher destiny can only be their own handiwork and that in its attainment, honesty and sincerity of purpose are as vital as cheerfulness and steadiness of co-operation. The task of the Government and leaders of the people will be to initiate, organize, direct and control this great nation-wide movement of social and political reconstruction.

The problem which it will be the concern of the ten-year plan to advocate, presents in the main a three-fold aspect, material, intellectual and moral advancement, none of which, in our opinion, can be treated as a water-tight compartment, capable of being taken up for consideration one after the other. These aspects are closely interdependent and a general campaign therefore for their uniform advancement must constitute the programme of the plan. It should be realized that the fundamental object of spreading education among the people is to enable every individual to discover to himself the talents which he can turn to the most stern account, to know and to practise that truthfulness and honesty of work must be the basis of all business transactions and to love and to serve one's neighbour is the condensed summary of all ethics and religion. People are slow to recognise that ignorance and slothfulness are an offence to themselves and a source of danger to the stability and progress of the society to which they belong: and without contributing to their elevation, will only tend to depress both by sapping their very substance. Through launching an active educational campaign, a steady and continuous advancement along three fronts is hoped to be achieved.

We shall briefly summarise the directions in which we believe that the reconstruction project should be carried on. A little reflection will make it clear that the first step is to mobilise all possible and available resources to accelerate the growth of material production. It stands to reason to suppose that a rapid output of industrial and agricultural produce is the primary condition for raising the material standard of life of the people. In order to do so, the first step ought to be to extend such of the factories and agricultural concerns as exist at present, to equip both with modern machinery, to build new factories and bring every inch of waste land under cultivation by an extended and comprehensive system of channel irrigation. It is well known that an increased output of labour implies improvement of methods of labour in general, and of skill and training of individual workers. Generally the workers in factories and agricultural pursuits are drawn from the rural population whose education and technical equipment amount at present to very little. They are saturated with antiquated and, in many cases, with traditional habits of work and their apathy towards progressive and scientific methods is almost proverbial. Consequently the first few years of the plan will have to be devoted to the problem of producing a new class of men, whose level of education and wider outlook will make them receptive of progressive ideas calculated to lift them into a higher plane of existence.

In order to transform the existing major industries so as to put them on to a higher technical basis and to found new ones, it becomes necessary to establish the closest possible connection between science, technology and production and to bring scientific work into intimate association with the solution of industrial problems, including transport and agriculture. All this is to be taken in hand in the preparatory stage which is also devoted to the improvement of the culture of the people and in fact educational development of the masses must synchronise with the industrialization of the country. The cultural work must be based on some form of compulsory popular education which will guarantee the advancement of the people, for this advancement implies the disappearance of illiteracy, improved technical training, and a progressive spirit. Then there is the question of rapidly training a competent and reliable band of young engineers and technicians from the ranks of the village population, which must necessarily involve the raising of the level of technical education in the rural areas.

We can hardly think of elevating the life of the people in any of its aspects without introducing at the same time some form of compulsory education in the country and it is doubtful if the cost of establishing compulsory free schools for an enormously large population like that of India, could be borne by the nation, without a portion of it being defrayed by the increasing output of industrial concerns. Here is an eternal tangle, whether educational expansion is to precede or to follow industrial development. In 1930, according to official statistics, the percentage of total scholars to the total

population was 5.1, which represents an increase of 0.2 over that of the previous year. In the same year out of a total of 9.22 million pupils undergoing instruction in the primary schools, only 1.32 millions went to the middle schools and 9.22 lakhs were found in the high schools and 9 02 thousand entered the university. These figures give an impressive idea of the wastage of pupils in every grade of education and the appalling waste of public funds on the so-called education of 8 millions of pupils who simply lapse into illiteracy again. Looking at the spread of education among the different communities, we discover that the percentage of pupils to the total of the Hindu community is 4.8, which is 0 6 per cent less than the Muslims and 17.4 per cent less than the Parsis and yet the Hindus form the major community of the total population. The average annual cost of educating a pupil is about Rs. 23-0-10 and of this amount nearly Rs. 20 brings little or no return to the expending authorities, on account of the wastage of pupils in the successive stages of their educational career. Without entering into the subject of industrial and technical schools, we have stated the problems arising from a perusal of the official documents relating to general education and we are struck by their formidable nature as soon as we try to find anything approaching a satisfactory solution under a ten-year plan. If we can devise means for preventing or minimising the volume of lapses into illiteracy, we shall consider ourselves as having offered a helpful suggestion to the promotion of education among the people of India. These problems and others directly or indirectly related to education, such as those pertaining to the industrial, economic, social and political life of the country, will be dealt with in our columns as time and space permit.

The cardinal point of our contention is that progress in any department of public activity should not be the outcome of mere accident or haphazard policy, but should be the result of pursuing a specific and carefully worked-out plan spread over a definite period of time. To ensure the success of such plans, the movements must spring from the heart of the people and must not be imposed on an unwilling and untrained populace. On the other hand, the authorities and well-to-do classes will have to realize sooner or later,—the sooner the better,—that they will be able to maintain for themselves the means of living in comparative opulence, leisure and comfort, only if the masses also are placed in a position to enjoy such a life at least in a small measure. The Earl of Oxford once declared of England that, "The course of our constitutional progress has been in the main not an alternation of revolution and reaction, but a course of more or less even development." We are of opinion that the progress in the spheres of human activity with which we propose to deal, should proceed uniformly and rapidly along the lines of equally "even development" and we propose to base our suggestions for a ten-year plan on this most acceptable and wise doctrine.

The Indian Institute of Science, Bangalore.

IT will have been a cause for general satisfaction among the Indian community of science to learn that Sir C. V. Raman has been appointed to the Directorship of the Indian Institute of Science, Bangalore, which becomes vacant early next year by the retirement of Dr. M. O. Forster. The occasion is a suitable one for reviewing some historical aspects of the Institute and forecasting a few developments which may be anticipated.

Since the opening of the laboratories in 1911, the Institute has always been a subject of considerable interest to the general public, which from time to time has offered advice directed towards improvement of its service to India. Such advice has not invariably taken the form of constructive criticism, because its authors have not sufficiently realized that a new institution, entirely novel to the country and therefore without a fund of experience on which to draw, must pass through an exploratory period of development before a recognizable tradition emerges. That stage having now been reached, however, the following observations may perhaps be regarded as timely.

Early expectations of revolutionary improvement in scientific industry and spectacular development of new industries, having been based on imperfect appreciation of the factors involved, were not fulfilled. Twenty years ago it was not generally realized that although laboratories for training students

in the scientific principles underlying industrial processes and in the methods of scientific research may be the cradle of a new industry, they cannot carry the infant enterprise beyond a very elementary stage. Higher authorities concerned in establishing the Institute were very definite on this point, however, as appears from a resolution by the Government of India in this matter, dated 27th May, 1909. During the discussion then prevailing, Government "were of opinion that the idea of combining in one institution, and entrusting to a single staff of professors, both the teaching of science and the experimental development of new industries, was open to the obvious criticism that these two objects were in no way connected with one another." Moreover, the two educational experts finally deputed to frame a scheme recommended "that the Institute should be devoted to experimental science, and should aim at training students in experimental methods, carrying on original research, and discharging the functions of an accepted authority and referee on all scientific problems within its own domain."

Furthermore, it is evident that these higher authorities appreciated the tentative aspect of the plan then to be launched, because in the concluding passages of the Resolution above quoted, the Governor-General in Council realized, "that the results of the experiment that is now about to be tried will depend less upon the conditions of the project itself than upon the character and energy of those who may come forward to take advantage of the facilities for advanced studies which it will offer." Finally, the Vesting Order founds "an Institute of Research in India" and the attached scheme of administration inculcates "the promotion of original investigation in all branches of knowledge and their utilization for the benefit of India," without specific mention of industrial activities.

Reflection on the cultural principles involved will tend to confirm the opinion of these authorities. If the training of students in methods of inquiry is to be the primary object of an institution—and the above quotations clearly establish that intention for the Institute—it is necessary that the subjects selected should have instructional value, and outside the factory itself such subjects are less commonly found among the class of problems arising from industrial processes than in the academic field. For example, a student might easily spend two years in trying (successfully or unsuccessfully) to raise by 5 per cent. the yield of a chemical product, without gaining much insight into the technique of chemical research: whereas, on the other hand, a well-chosen academic exercise may in the same period equip him with the mental machinery for solving many problems quite alien to the one he did solve. Moreover, modern industrial research has long passed beyond the stage when a lad of eighteen, trying to synthesise quinine, can stumble on mauve and then, by an amazing exertion of skilful diligence and the loyal support of his relatives, proceed to found a colossal new industry. The successful application of science to manufacture nowadays depends principally on team work by highly trained men, temporarily freed from the necessity of equipping themselves with further technical qualifications and then seeking employment. Those who think otherwise may profitably study *Searching into the Unknown*, by the General Electric Company, Schenectady, N.Y.

Nevertheless it is apparent that those responsible for developing the resources of the Institute, while placing in the foreground the requirement to impart advanced knowledge, and instruct in the methods of research, have consistently kept in mind any possible bearing which the results may have on the inception of new industries and the improvement of existing ones. Ample evidence of this recurs each year in the appendix to the Council's report, showing in abridged form the current subjects of investigation; but although the technological application of the work at the Institute has been wide, and in several cases valuable, there is doubtless room for expansion in this field. As pointed out by the Quinquennial Reviewing Committee, there should be close collaboration between the Institute and the Scientific Surveys, the Telegraphs Department, the Meteorological Department, the Railway Board, Chambers of Commerce and the Directors of Industry throughout India. Association with these entities does occur, but it has not resulted in many problems being referred to the Institute.

Most of the subjects with an economic application latterly engaging the attention of the Institute have in fact been initiated therein, as instanced by the systematic inquiry into the cause of spike-disease in sandal. This has now continued during the past five years in co-operation with the

Government of Madras and the Coorg Commission, the results being summarized in periodical reports published separately from the Journal of the Institute. The latter publication contains a description of the various inquiries, academic and economic, which have been pursued in the laboratories and in the past fifteen years has comprised about 200 issues. The range of subjects is wide, and includes many that might be turned to an industrial utilization of principles or materials. This aspect of the work is reflected in the fact that the major proportion of the Institute's former students have been absorbed into non-academic occupations, particularly in the field of electrical technology. The development of this department has been very notable, both in heavy electrical engineering and in the section of electrical communication; and in this connection it may be explained that the primary object of the department has been to provide advanced courses of instruction supplementary to those obtainable in the universities and engineering colleges. Hitherto, the facility with which students trained at the Institute have gained employment in the rapidly growing electrical industries has disinclined all but a small proportion to prolong their sojourn at the Institute for the purpose of research.

The main object for which the Institute was founded, as defined above, is being steadily enlarged. Fifteen years ago the number of workers in the various departments was 41; during the year lately closed the corresponding total was 142. In the same period the strength of the staff has grown from 9 to 26, and it is noteworthy that of this number 19 are former students of the Institute, thus fulfilling one of the most earnestly cherished wishes of the late Founder, Sir Dorabji Tata. Out of all proportion to the growth in the number of students has been the increased aid rendered annually in the form of scholarships, etc., which has expanded from Rs. 4,700 to Rs. 53,800, while expenditure on working and equipping the laboratories has trebled, being Rs. 65,100 against Rs. 22,600. Fifteen years ago the outlay on periodicals and new books was Rs. 2,100, while to-day it is Rs. 16,000.

Although this chronicle of development suggests that the financial position of the Institute is reassuring, there are some features of instability to which attention should be drawn. Sir Dorabji Tata's hope, shared by all those who have the progress of the Institute at heart, was that it shou become an all-India institution. In tl sense that its students are drawn fro almost every part of the sub-continent tl hope has been realized with this reservatio that for geographical reasons a large preponderating number is received fro Mysore and Madras. It is regrettable, hov ever, that this all-India feature is n reflected in the sources of revenue. Amon these the return on the original endowmer with interest on savings and the annu subvention by Government of India repre sent 88 per cent. of the total, and the majo portion of the remainder is contributed b the Government of H. H. the Maharaj of Mysore, which has generously grante Rs. 50,000 per annum hitherto, in conformit with a promise made when Bangalore wa finally selected for locating the Institute From this it follows that, excepting Mysor and Hyderabad, which also has uniforml and generously supported the Institute contributions from States and Provinces hav been disproportionate to the benefits receive by their students. For example, althoug during the past six years the numbers deriving from Mysore, Madras and Bomba have been approximately the same, with a distinctive advantage in favour of the two last named, the respective contributions have been Rs. 50,000, Rs. 5,000 and nil. This discrepancy calls for rectification, on grounds both moral and material. In the first place, absence of support from Bombay and Bengal may be used by other regions as an excuse for withholding assistance, or for reducing such aid as may be given already, and secondly, the revenue of the Institute has remained for some years stationary, and at the moment is declining.

Accordingly, it is necessary that wider resources become available, and without undue delay. With this provision the future, to which we now look for progress and expansion at least comparable with those of the last fifteen years, is full of hope. This is not the place in which to panegyrise the scientific achievements of Sir Venkata Raman. These have not remained in obscurity, and they give promise that the Institute, without in any way diminishing its interest in possible industrial applications of its work, will add to its academic resources a department of physics as a link between existing activities in physical chemistry and electrical technology.

ALCHYMIST.

Unemployment in India.

SIR M. VISVESVARAYA'S thoughtful address[1] before the University Union, Bangalore, has provoked a considerable amount of fresh interest in this "Master Problem" of the age and, as mentioned in our previous number,[2] we take this opportunity to discuss the subject, in greater detail, in the light of the valuable suggestions made by that veteran statesman.

A critical study of the various causes which led to the present situation would show that, although the world-wide economic distress is partly contributory to increasing unemployment, the main causes are deep-seated and inherent to the conditions prevalent in India. Among the latter may be mentioned, (*a*) the disproportionately rapid growth of population in comparison with the limited resources of the country, (*b*) unbalanced occupational structure arising from neglect of industries and overcrowding on land, (*c*) want of adequate efforts on the part of the Government to encourage industries and to explore new avenues for increasing employment, and (*d*) certain defects due to faulty traditions of the people and disabilities arising largely from the trade policy and other similar measures pursued, for a long time past, with regard to the country.

During the past few years, the trade returns of the country have diminished considerably while the population has greatly increased. The birth rates are now far higher and the average income considerably less than those of most European countries, so that the standard of living has gone down with increased poverty and misery all round. According to certain thinkers, restriction of population has now become a necessity and it is pointed out that birth-control measures so successfully practised in all civilized countries should be adopted more extensively than in the past.

This view may not be shared by a certain section of the public, but, considering the already under-nourished condition of majority of women and children and the fatal consequences of frequent motherhood, it must be admitted that some voluntary type of birth restriction is in the opinion of these advocates needed to improve the general condition of, at any rate, a great majority of the population.

As Sir Visvesvaraya pertinently points out, the pressure on land has lately increased considerably without any appreciable improvement in output; indeed, recent statistics show that the total area under cultivation has appreciably diminished during the past few years. The above are largely due to (*a*) the agricultural population having increased out of all proportion with their earning capacity and (*b*) decreased foreign demand for Indian agricultural produce. Many of the countries that were once buying from India are now either raising the required articles or their substitutes in their own countries or are buying them from cheaper rivals. Although our cost of production is lower than those of most other countries, we lack cheap transport facilities and requisite organization for collecting and disposing of produce so that we are unable to compete with our rivals and are thus steadily losing ground on foreign markets. The majority of the agriculturists themselves are not, however, aware of this situation and early steps should be taken to educate them to their position and to stimulate co-operative effort to reduce the cost of production, improve the yield, pool the produce and organize internal as well as external trade.

So far, the main occupation of the majority of the population consisted in the production of raw materials for food and clothing which were disposed of, as such, to the buyers in the country and abroad. Except in textiles very little effort has so far been made to convert the produce into more valuable finished articles. As mentioned in a previous number,[3] the majority of the articles that contribute to human comfort and well-being are derived from agricultural produce and well placed as we are with regard to cheap man-power, a considerable portion of our future efforts should be directed towards the promotion of industries relating to the utilization of agricultural produce. Such a policy which requires the active support of the Government would not only relieve congestion on land but also stimulate output from the soil.

Although agriculture is the basic industry of the human race, it is yet a precarious

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[1] Now published as 'Unemployment in India: Its causes and Cure', Bangalore Press, Bangalore (1932).

[2] *Cur. Sci.*, **1**, 60 (1932).

[3] *Cur. Sci.*, **1**, 30 (1932).

means of livelihood and the experience of the more progressive countries like the United States, Canada, Great Britain and Japan show convincingly that industrial development is absolutely essential to ensure the prosperity of a nation. The industry of to-day connotes imagination, organization and enterprise, the key to all worldly comforts that make life worth while; it is the very breath of civilization and the sign of modern progress. It need, therefore, be hardly urged that efforts of the Government as also of the public should be directed towards the promotion of industries and encouraging native enterprise.

About a century ago India exported cotton, textiles, steel and sugar to Europe, but now she is importing the same products from abroad and paying for them between 50 to 70 crores of rupees per annum. The ancient arts and manufactures which were once the pride of the Orient have steadily passed into decay while the policy of free trade and the system of internal taxation adopted in the past facilitated the unrestricted dumping of foreign produce resulting in the extinction of initiative in the people. Even to-day, the Development Departments of the different provinces as also the Department of Industries and Commerce of the Central Government are not in a position to render much assistance towards the promotion of new industries. The provincial departments have very little money for nation-building activities while the Imperial Government confines its interests to the publication of bulletins of general information. The latter are, no doubt, useful but they should provide fresh ideas with regard to possible future developments if they are to materially assist the industrial development of the country. In all the progressive countries new industries have generally originated from active co-operation between the Government on the one hand and the technical men and business magnates on the other; in the early stages, at any rate, the necessary tariff protection is afforded and material assistance rendered to facilitate the perfection of the related processes. India should adopt a similar policy if she is to make any headway as a manufacturing nation.

While the best energies are required in other directions, it is indeed highly deplorable that a considerable amount of national talent is being frittered away in wasteful pursuits. The majority of the moneyed classes do no work at all: nor do they have the ambition to improve their resources by assisting productive ventures. Almost the entire population of women—particularly the married ones—have no useful occupations. There are a number of minor and even major industries to which women, working in their homes, can render considerable help and, at the same time, receive useful remuneration that would materially add to their resources. We do not, however, think that the time is yet ripe for women to compete with men in the regular services, but may well hope that with increased industrial development there may be employment for all available talent in the country.

Unemployment among the educated classes is far more distressing to-day than that among the others. The majority of the former are derived from the lower middle classes of the country who have staked their modest means to qualify for livelihood, but their object is not to be attained. There are thousands of graduates—not to mention the larger numbers of less qualified persons—who have received high liberal education which has given them the valuable intellectual outlook but not the practical insight that would provide means of independent livelihood. Our present system of education, though praiseworthy in other respects, does not qualify men and women for the business of life and it is high time that drastic reforms were introduced making the higher training largely vocational and extending the instruction to scientific agriculture, engineering, chemical technology and higher commerce. An immediate difficulty in the perfection of the above scheme is the finding of men and women with the necessary practical experience to train others; but considering that other countries had to begin the same way, it is not too much to expect that with the changed outlook and adequate encouragement the required type of talent would soon be available.

Adult education would no doubt be of considerable value in both urban and rural areas but it would not prove to be of much assistance unless the training is so directed as to improve the earning capacity of the people. Efforts should be made to establish experimental night schools whereat free training will be imparted in the best ways of conducting business or agricultural operations. The teaching could be done by men and women with commercial or agricultural training who may be paid small honoraria for doing the work. In this, as in other

things, the initiative should come from the Government. Sir Visvesvaraya lays the necessary stress on the need for rapid industrialization and makes valuable suggestions for the organization of small, medium or large scale industries. We are, however, rather diffident about the working of some of them at any rate under the Indian conditions. Thus, although it is highly desirable to have co-operative ventures in rural areas it would require more than ordinary effort on the part of an organizer to keep the community together. Moreover, the people will have to pass through years of training before they could be brought to appreciate the need for such organizations. On the other hand, if capable organizers with the single objects, such as, say preparation of nitre or manufacture of fruit syrup as determined by the facilities of the place, should get the work done by a representative section of householders who would receive payment for the work, then that will prove an incentive for the others to follow.

With regard to the organization of medium and major industries, the information at the disposal of the chambers of commerce or industrial organizations is hardly sufficient for starting such ventures. Past experience in inviting outside experts for short periods to initiate new industries has also not been very happy. The experts are naturally reluctant to part with all their knowledge as that would be the very undoing of their own positions.

To our mind, the best means of initiating new industries is through the organization of a fairly stable *Development Commission* as in the case of Great Britain or Australia who would first tour the country, meet the representatives of technical sciences, agriculture, industries and commerce, study the various possibilities first hand and with the co-operation of small expert committees, prepare systematic plans of industrial undertakings. The related processes may then be worked out, on small scale, either at some central research station which would be directly under the Commission or, preferably, in private institutions aided by the Commission. The Commission as well as its expert Committees would keep in continuous touch with the developments and issue periodical bulletins of progress for the information of the public. When the experimental stage is passed, the Commission should invite interested business men to try out the results on semi-commercial scale, the cost of the trials as also the salaries of the technicians conducting the work being borne by the Commission so that the feasibility of the processes may be fully demonstrated without any expense to the interested bodies. Once that stage is reached and the processes have proved successful, the Commission should relax their interest so that private enterprise may have scope to do the rest. They should, no doubt, hold themselves in readiness to assist in the solution of further problems arising in connection with the same and related industries, but beyond defining the fundamentals they should leave all developments to private enterprise. In addition to initiating new industries, the Commission should also keep in touch with similar organizations like the Imperial Council of Agricultural Research, the Indian Research Fund Association, the Indian Institute of Science, the Zoological, the Geological and the Botanical Surveys of India so that they may have information from all points of view before undertaking even their experimental ventures.

It may be suggested that the Commission should include at least one technical chemist, an engineer, an industrialist with experience in organization and a business man with sound knowledge of trade in India and abroad. All the members of the Commission should have thorough knowledge of the country and its resources. They should be appointed, preferably on the contract basis, for periods of say 5 years at a time with the stipulation that they should not possess any private consulting or other business interests, at any rate, during the term of office. The Commission as a whole should be independent of the Government though assisted by it. They should have the power of augmenting their resources by receiving subsidies or donations from Native States or philanthropic individuals, but they should not receive any assistance from private commercial interests.

The above scheme could be elaborated still further but the present is hardly the occasion to do so. It is, however, sincerely hoped that the attention of the Government as well as the leaders of the public would be drawn to the thoughtful utterances of Sir M. Visvesvaraya so that India which will soon receive a large measure of self-government, may also be alive to the importance of economic freedom which is the key to the solution of unemployment.

Development of Pharmaceutical Industry in India.

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DURING the last few years with the spread of the spirit of *Swadeshi*, the demand for Indian-made goods has been gaining considerable ground in this country. Consequently, a number of new industries wherein the resources of the country can well be utilized, have sprung up recently. Certain industries like the textiles, soaps and a few others have advanced far enough and it can be said with a certain amount of confidence that if necessity arises, India can meet her own demands for the products of these industries, while pharmaceutical industry, in spite of the plentiful source of a number of raw materials, is still in an infant state. Perhaps one may account for this by saying that comparatively a very small percentage of the people in this country have acquired the habit of using allopathic medicines. Still one would be surprised at the vast amount of money spent in importing these allopathic medicines from foreign countries. Statistics for the last five years show that India imports annually drugs and medicines (excluding chemicals) worth about two crores of rupees.

In dealing with the development of the various aspects of the industry, it is essential in the first place to discuss some of the serious difficulties which this infant industry in India is facing to-day.

The most rigid and inconvenient excise regulations form one of the serious difficulties in the way of the development of the Indian industry. Hindrance to the free movement of alcoholic preparations in inter-provincial trade due to diverse excise regulations in different provinces, restrictions to the use of duty-free alcohol for manufacturing purposes and comparatively high cost of maintaining a bonded laboratory and a warehouse for the manufacture of alcoholic preparations are among the chief difficulties arising out of excise regulations.

Paucity of reliable crude materials is another serious difficulty. Although crude vegetable drugs are available in plenty, there are no reliable dealers who can supply the manufacturers regularly with medicinal herbs of the proper quality. This is partly due to the ignorance of the people who collect the drugs from forests without taking any special care to avoid the decomposition or the destruction of active principles, and partly to the general tendency to adulterate such drugs. In the absence of any definite law in the country prohibiting the manufacture, import or sale of adulterated or inferior quality drugs, unhealthy competition has made it extremely difficult for manufacturers of drugs of standard quality to compete with those, who, whether foreign or local manufacturers, do not hesitate to sacrifice quality, or resort to adulteration to satisfy the popular demand for cheap medicines. In addition to these, lack of cheap transportation facilities, excessive tariff on the import of crude drugs not available in India and the absence of scientific research along pharmaceutical lines are among the other factors which hinder the development of the industry in the country.

For the purpose of discussion pharmaceu' industry in India can be roughly divided five parts, namely, the manufacture of

(1) spiritious galenicals, such as, tinctu extracts, etc.,
(2) biological substances, such as, vacci sera and glandular products,
(3) active principles of vegetable drugs, as, glucosides, alkaloids, essential fixed oils, etc.,
(4) pure organic and inorganic medi chemicals,
(5) and lastly. the cultivation, collection further preparation of crude botan drugs.

(1) This is the branch to which most of Indian pharmaceutical houses are confining t activities, partly on account of the compara simplicity of the machinery and the proces manufacture and partly on account of the a ability of almost all the raw materials in country. There seems to be, therefore, no re why practically all our requirements pertai to such preparations should not be manufact in India. With a little more sympathetic tude on the part of the excise department an earnest attempt on the part of the growers collectors of crude vegetable drugs to su materials of proper quality there seems to b difficulty in the development of this part of industry.

(2) The most important requirement for manufacture of products under this divisio the availability of sufficient raw material of able quality. The large number of slaug houses will provide raw material which i present wasted and certain local conditions as the comparative freshness of the raw mat the animals living in the local environments the utilization of local strains of organisms the added advantage to the Indian manufactu Although certain Indian manufacturing ho are successfully manufacturing biological ducts, it is a matter of doubt whether these eventually be able to successfully compete American or European manufacturers. latter have the great advantage of easy a to suitable raw materials from their well-or ized meat-packing industry. Furthermore, the inherent non-violent nature of the ave Indian, it is highly doubtful whether it wi possible in the near future to develop ca breeding as an industry with the ultimate o of utilizing such cattle for the manufactu glandular and similar biological products. S sera and vaccine are concerned there are no serious difficulties in the way.

(3) Except the manufacture of quinine in Government factories at the Nilgiris and Da ling and in one or two private factories, not r manufacturing is done in India along the lin preparing active principles from crude vege drugs. India is the principal source and in cases the only source of many vegetable c materials from which active principles like

loids and glucosides are manufactured. If the excise regulations are liberalized many products like santonin, strychnine, berberine, caffeine and atropine and many essential and fixed oil medicinal preparations can be easily and economically manufactured in India.

(4) Since the World War organic chemistry has made tremendous progress in the domain of synthetic medicinal compounds. The manufacture of such substances in India at the present state of her industrial position is, however, confronted with many difficulties. The most serious of such difficulties is the lack of a well-established chemical industry in the country. Although a few organo-metallic compounds like urea-stibamine are manufactured in India, this branch of the industry cannot very well succeed unless a general all-round development of the chemical industry takes place in the country.

(5) This part of the industry has not received as much attention in this country as it deserves. We have been so far relying entirely on the natural resources of the country. In order to make India self-sufficient and to supply raw materials of known and good quality to manufacturers, it is essential and desirable that cultivation of medicinal plants is thought of more seriously. India possesses varying climatic conditions. It is, therefore, possible that medicinal plants which are not growing within her boundaries may be made to do so. Thus cultivation applies not only to such plants but also to those growing wildly in a scattered condition. In the case of the latter it more often happens that the cost of collection and transportation becomes extremely heavy when we consider the high railway freight charges in the country. In advanced countries like Germany, England, United States of America, Belgium and France, medicinal and essential oil plant cultivation has proved a great success. Attempts in this direction are now being made in certain parts of Northern India. The Government of Kashmir, in addition to careful tapping of vast resources of their forest, are making earnest attempts to cultivate some very important drugs. The U. P. Government has also taken keen interest in this problem as part of their programme for agricultural development of the province.

Pharmaceutical industry like many of the highly technical industries requires the help of men of scientific attainments and expert knowledge. A number of problems connected with the various aspects of the industry discussed above need the services of various scientific men. A large number of vegetable drugs used medicinally in India still await chemical and pharmacological examination on modern lines and some of these at least, on careful study, may prove very good substitutes for the foreign costly drugs imported now. Methods of preservation of various galenicals under the Indian climatic conditions will have to be worked out. Processes for the isolation or extraction of active principles from the drugs already investigated will have to be devised. Optimum conditions will have to be found out for the successful cultivation of many drugs now growing wildly or acclimatized.

There are other equally important problems which even a scientist interested in pure academic research can help the industry. One of the serious difficulties in the way of a healthy growth of pharmaceutical industry in India is the problem of gross adulteration of crude and finished medicinal substances. This situation has become so acute that the Government of India appointed a Drugs Enquiry Committee in August 1930 to "enquire into the extent to which drugs and chemicals of impure quality or defective strength, particularly those recognized by the British Pharmacopœia are imported, manufactured or sold in British India and the necessity in the public interest, of controlling such importation, manufacture and sale and to make recommendations."

The Committee met, toured all over India, made an exhaustive enquiry and the findings and the recommendations of that Committee are embodied in the report published last October (1931) by the Government of India. The Committee have recommended certain ways and means of combating this evil of adulteration. Among many important suggestions, recommendations have been made for the enactment of a Drugs and Pharmacy Act and in order to enforce the provisions of such an Act, the compilation of a standard authority like the Indian Pharmacopœia.

For the moment the provisions of the Act may be left out of consideration; only the compilation of the Indian Pharmacopœia needs to be considered as far as scientists are considered. Methods of identification including chemical and biological assays of various botanical drugs and their preparations will have to be standardized. Very delicate methods for the isolation, identification and estimation of various adulterants will have to be devised. It is not very difficult to imagine the up-hill task of the Indian scientist when the inclusion of a number of indigenous preparations in the Indian Pharmacopœia is proposed. However, when the passing of the Drugs and Pharmacy Act becomes an accomplished fact and the best scientific brains of the country are called upon to share the responsibility of compiling the Indian Pharmacopœia, let us hope that the Indian scientists will not be lacking in their efforts to accomplish such an end.

Considering the situation of the various aspects of the industry as a whole, one can say with a certain amount of confidence, that, in spite of the serious handicaps an infant industry has to undergo, there is still wide scope for the development of the pharmaceutical industry in India. There are enough raw materials available; a large portion of the machinery can be manufactured in India; there are certainly scientifically trained young men who are willing to undertake the work if sufficient encouragement is given. There are not many insurmountable difficulties. On the other hand there is everything in favour of such an enterprise. The consumer will be enabled to get really potent preparations probably at less cost. A new industry with great potentialities will be started and finally an opportunity will be provided for harnessing the Indian talent for chemical and biological research.

Letters to the Editor.

Grammatopteris, a Link between the Osmundaceæ and Zygopterideæ.

THE well-known theory that the Osmundaceæ and Zygopterideæ arose from a common stock was one of the main results of Kidston and Gwynne-Vaughan's classical work on the Fossil Osmundeceæ.[1] This view was based chiefly upon a comparison of the genera *Thamnopteris* and *Zalesskya*, both from the Upper Permian of Russia, with certain Palæozoic Zygopterideæ. It is unfortunate that during the life-time of these authors the Lower Permian genus *Grammatopteris* of Renault[2] was only very imperfectly known; for, as they acutely suggested in 1907, this genus "possesses a type of structure that may be regarded as primitively Osmundaceous".[3] In 1918 the present writer ventured the opinion that in rocks older than those which have yielded the most primitive known Osmundaceæ (*Zalesskya* and *Thamnopteris*) "forms may yet be discovered which it would be difficult to assign to one or the other of these families. Indeed, it may be that we already have one such form in *Grammatopteris Rigolloti*".[4] Our knowledge of the type-specimen still remains where it was thirty-seven years ago, but my reinvestigation of an allied species, *G. Baldaufi*,[5] discovered in the Lower Permian of Chemnitz (Saxony), has shown that *Grammatopteris* is indeed a synthetic type of great interest, simpler in structure as well as geologically older than both *Thamnopteris* and *Zalesskya*. While a full description of *G. Baldaufi* will shortly appear elsewhere,[6] a few of the main features of theoretical interest may be summarised here. The type-specimen was originally described by Beck under a new generic name, *Protothamnopteris* in ignorance of Renault's work. The habit was that of a small tree-fern with the base of the stem clothed in a felt of adventitious roots. The petioles were cylindrical, as in the Zygopterideæ; they were devoid of the stipular expansions so constantly found in the Osmundaceæ, both recent and fossil. The stem had a solid protostele, consisting only of tracheids, but faintly differentiated into a stellate central xylem, composed of mixed ordinary and parenchymatous tracheids, and a relatively thin outer xylem. The periphery of the outer xylem was more or less deeply invaginated by narrow vertical slits which no doubt represent rudimentary leaf gaps homologous with those of the Osmundaceæ. The protoxylem cannot be located with certainty but was probably represented by scattered groups of narrow tracheids in the central xylem. The leaf traces arose in spiral sequence, the phyllataxis varying from about 5/13 near the base to a more crowded arrangement, like that of *Thamnopteris* and other Osmundaceæ, higher up. The foliar trace was at first elliptic in cross-section, but finally assumed the form of a straight tangential band with the two marginal protoxylems characteristic of the genus. It is probably a fact of some phylogenetic significance that this simple type of foliar bundle fits in readily with the zygopterid ground-plan. Diarch roots arose from the abaxial sides of the leaf-traces in the region of the cortex.

Thus, while in its foliar characters *Grammatopteris* clearly approaches the Zygopterideæ, its stem structure is paralleled by members of both the Osmundaceæ and the Zygopterideæ. On the whole there seems to me to be a somewhat stronger case for regarding the genus as azygopterid than for referring it to the Osmundaceæ. Professor A. C. Seward, F.R.S., to whom I am deeply indebted for opportunities of discussion, is inclined to think that the affinities are rather more on the side of the Osmundaceæ. I am prepared to confess that the balance is very nearly even and that my choice may have been largely influenced by the personal factor. But the main point is that we cannot with full confidence assign the genus to either of these families, and this is perhaps the strongest proof of their affinity and their common ancestry.

B. SAHNI.

University of Lucknow,
September 25, 1932.

1 *The Fossil Osmundaceæ*, Pts. I-V. Trans. Roy. Soc. Edinb., Vols. XLV–XLVII, L. Pt. 3, pp. 663–664; Pt. 4, pp. 466–473 (1907–1914).

2 *Bassin houiller et permien d'Autum et d'Epinac*, II (1896).

3 *loc. cit.*, Pt. 1, p. 778.

4 *Ann. of Bot.*, **32**, 374, 1918.

5 Beck, R., "Ueber *Protothamnopteris*", *Abh. Sächs. Akad. Wiss.*, **36**, V, 1920.

6 *Ann. of Bot.* (Current volume).

Hyperfine Structure of Mercury Lines.

THE hyperfine structure of mercury lines has been studied by various observers but the results do not uniformly agree. Starting from the structure of λ 4916 $(6^1P_1 - 8^1S_0)$ given by Venkatesachar and Sibaiya,[1] the author and T. G. Srinivasa Iyengar[2] set up a term scheme to explain the structure of

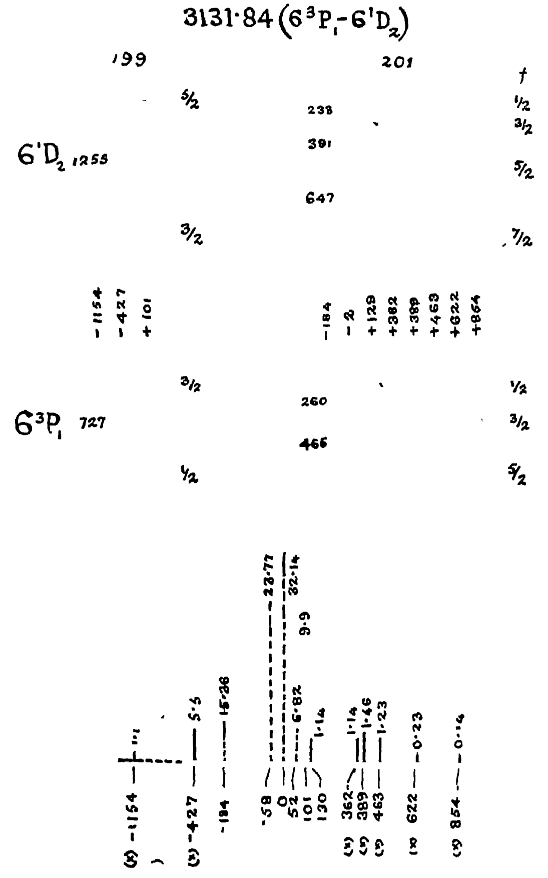


Fig. 1.

4916, 5791 $(6^1P_1 - 6^1D_2)$ and 5770 $(6^1P_1 - 6^3D_2)$. The structure of 3654 $(6^3P_2 - 6^3D_2)$ and 3125 $(6^3P_1 - 6^3D_2)$ was thence deduced and found to be in agreement with that recorded by Nagaoka.[3] Schüler and Jones[4] and Murakawa[5] have given another term scheme for these lines, based upon the structure of 4916 found by Schüler and Keyston[6] and Murakawa[7] respectively. The measurements of Nagaoka are in better accord with the scheme given in the paper above referred to.[2] Schüler and Jones[8] have recently found it necessary to alter the level scheme of 5791 in order to bring it into accord with the structure given by Görlich and Lau,[9] which, however, still contains some compo-

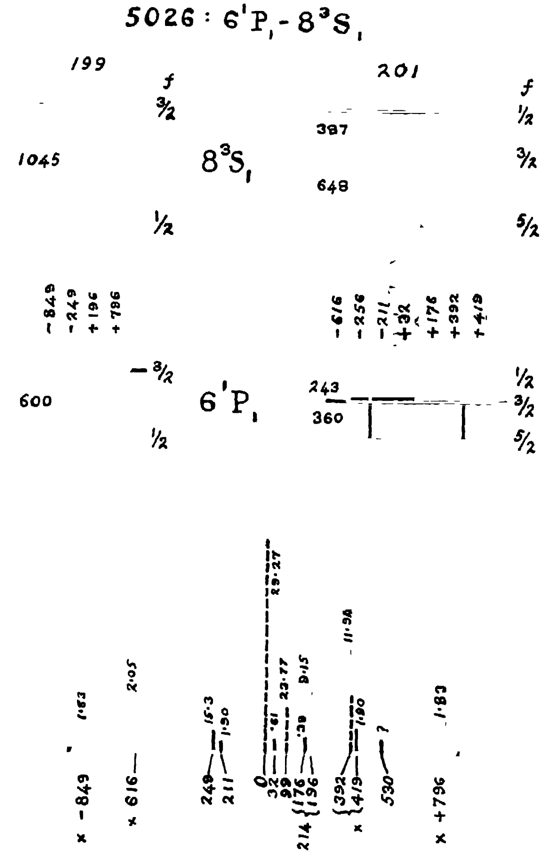


Fig. 2.

nents not coming under Schüler's scheme. The scheme set up by Murakawa is substantially the same as that of Schüler and Jones[4] except that the level-separations are slightly different corresponding to differences in the wave-number separations of the satellites. Now this scheme gives for 3131.84 $(6^3P_1 - 6^1D_2)$ a structure very different from that of Nagaoka, which can, however, be explained

[1] *Journ. Mys. Uni.*, **4**, 148, 1930.

[2] *Proc. Roy. Soc*, **A. 137**, 216, 1932.

[3] Quoted by Ruark, *Phil. Mag.*, **1**, 977, 1926.

[4] *Zs. f. Phys.*, **74**, 63, 1932.

[5] *Sci. Papers Inst. Phys. Chem. Res., Tokyo*, **18**, 177, 1932.

[6] *Zs. f. Phys.*, **72**, 423, 1931.

[7] *Zs. f. Phys.*, **73**, 366, 1931.

[8] *Zs. f. Phys.*, **77**, 801, 1932.

[9] *Zs. f. Phys.*, **77**, 746, 1932.

as shown in Fig. 1 on the basis of the scheme proposed by the author and T. G. Srinivasa Iyengar. This scheme is also able to account for the structure of 5026 ($6^1P_1 - 8^3S_1$) given by Venkatesachar and Sibaiya[10] as shown in Fig. 2. The scheme of Schüler and Jones cannot be reconciled with this structure. Fig. 3 shows the structure of

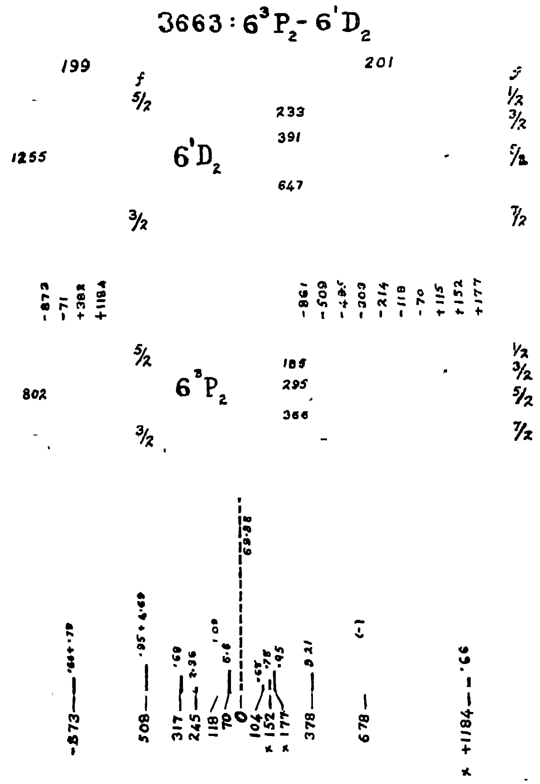


Fig. 3.

3663 ($6^3P_2 - 6^1D_2$) deduced from that of the 6^1D_2 level given in the previous paper.[2] Unfortunately the diagram given in that paper for 3663 shows the levels upside down owing to inadvertence in copying from the rough manuscript. The positions of the satellites now given agree with the measurements of Nagaoka although the intensities are not so well explained. The structure deduced by Schüler and Jones is markedly different from that given by Nagaoka.

It is remarkable that the structures of some lines in regard to which earlier observers were in substantial agreement differ materially from the results of later investigators. The situation is equally puzzling in the case of lead. Thus Wali Mohamma and Sharma[11] obtain results exactly coincid ing with those of previous observers lik Janicki while in many cases the results (Kopfermann[12] and the similar ones of Ros and Granath[13] differ markedly from thes It is not easy to make self-reversal an absorption alone responsible for suc contrary results. Unless the causes of th discrepancy between the results of equall reliable observers are found out and allowe for, the problem of hyperfine structure wi remain without a unique solution.

T. S. SUBBARAYA.

Department of Physics,
Central College, Bangalore.

¹⁰ *Naturwiss*, **19**, 1041, 1931.

Size of the Liquid Drops on the Same Liquid Surface.

IN the previous papers the author has studi the general accounts of the liquid drops on tl same liquid surface,[14] the effect of the su rounding medium on the life of liquid drops and water as a suitable liquid for tl formation of such drops.[16] Now the auth has studied the factors which increase the size and has arrived at the following co clusions :—

1. That the size of the floating dro depends upon two factors, *viz.*, (*a*) the di meter of the burette and (*b*) the surfa tension of the mother liquid.
2. That the size of the floating drops independent of (*a*) the viscosity and (the density of the mother liquid.
3. That the surface tension of the moth liquid affects the size of the primary as well the secondary drops formed by any metho
4. That the diameter of the jet affec the size of only the primary drops formed l burette method. It neither affects the prima drops formed by any other method nor tl secondary drops formed by any method.

L. D. MAHAJAN.

Camp—Sundarnagar,
Suket State, India,
September 12, 1932.

11 *Phil. Mag.*, **12**, 1106, 1931.
12 *Zs. f. Phys.*, **75**, 363, 1932.
13 *Phys. Rev.*, **39**, 1017, 1932.
14 J. B. Seth, C. Ananda and L. D. Mahaja "Liquid Drops on the Same Liquid Surface," *Pl Mag.*, **7**, pp. 247-253.
15 L. D. Mahajan, "The effect of the surrour ing medium on the life of liquid drops," *P Mag.*, **10**, pp. 383-386.
16 L. D. Mahajan, "Liquid Drops on the Sa Liquid Surface," *Nature*, **126**, p. 761; **127**, p. 70.

Chromosome Number in Pyrgomorphinæ (Acrididæ).

WITH reference to a preliminary note on the "Chromosome Number in Pyrgomorphinæ", by Mr. Ramachandra Rao in these columns,[1] I wish to state that observations on chromosome number, sexchromosome, etc., in the male germ-cells of *Poeciloeera*, *Pyrgomorpha*, *Colemania* and *Chrotogonus* have been published by me in the form of short notes.[2] I have also observed the remarkable deviations noted by him in the chromosomal complex of Pyrgomorphinæ in the genera mentioned above.

With regard to the chromosomes of *Colemania* and *Chrotogonus*, it is gratifying to note that Mr. Ramachandra Rao in his preliminary communication to this journal confirms what has been observed by me elsewhere.

A paper embodying the observations on the chromosomes of these forms will be published soon.

J. J. ASANA.

Ismail College,
Jogeshwari (Bombay),
September 22, 1932.

Further Notes on the Chromosomes of Pyrgomorphinæ.

IN the note on the chromosome number in Pyrgomorphinæ, published by me in *Current Science* (August 1932) I recorded preliminary observations on *Colemania*, *Chrotogonus* and *Aularches* and omitted to mention the previous work of Prof. Asana on the same subject which he has communicated to the Indian Science Congress in 1928 and 1930. The reason for this omission is not to rob the Professor of the merit for priority which would be handsomely acknowledged in my fuller paper which is in the course of preparation and moreover my published account will be found to differ from his observations in certain material respects. Further, my work on *Colemania* has been undertaken mainly with a view to determine the possible relation of the changes in the germ cycle of the male forms with the periodicity of their occurrence and I extended my studies to the allied forms for securing collateral evidence in support of the views I am led to form from an examination of my material. There are only two forms *Colemania* and *Chrotogonus* which form the common subject of investigation by Prof. Asana and myself, and in the case of the latter I differ from him in certain regards.

The present communication refers to the extension of my studies of the chromosome behaviour in *Orthacris*, another Pyrgomorphine, fairly common in Mysore, feeding largely on mulberry. This genus shares the general chromosome characteristics of the sub-family in possessing the reduced number of chromosomes. The diploid number in the male is 19. There are the usual ring, rod, and V-shaped tetrads (Fig. 1). A very

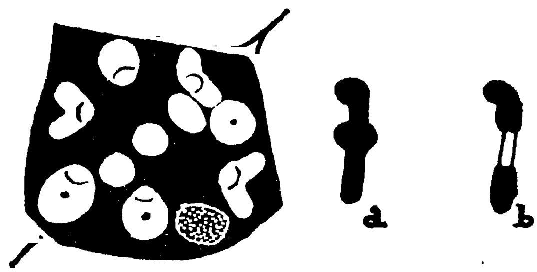


Fig. 1. Fig. 2.

interesting feature is the occurrence in the first spermatocyte metaphases of one of the individuals studied, a J-shaped tetrad (Fig. 2). This is due to the presence of a pair of heteromorphic homologous chromosomes, resulting from the fact that in one of the homologues the spindle fibre attachment has shifted from the usual terminal position and assumed an atelomitic condition. Fig. 2 *a* shows the tetrad placed on the spindle axis and Fig. 2 *b* an early anaphase where the dissimilar homologues are separating. More specimens are being examined for finding out whether such forms occur more often and efforts are also being made to discover why exactly the shifting of the fibre attachment has taken place. A detailed paper on the spermatogenesis of *Orthacris* will be communicated to the next Science Congress at Patna.

T. RAMACHANDRA RAO.

Department of Zoology,
Central College,
Bangalore.

[1] *Cur. Sc.*, Vol. I, No. 2, p. 41.
[2] *Proc. Ind. Science Congress*, 1928, 1930, 1931.

Development of the Female Gametophyte and Embryo in *Spiranthes australis* (Lindley).

IN the course of the researches on the Orchid embryo-sac and embryos, the following interesting observations have been made in *Spiranthes australis* (Lindley).

The Megaspore-mother cell (Fig. 1) undergoes the various stages of Hetero- and homotypic divisions (Figs. 2 to 10) and forms the "linear tetrad" (Fig. 11). All the four cells of the tetrad function to form an embryo directly by further divisions (Figs. 12, 13, 14) instead of going through the different usual stages, namely, the degeneration of the three megaspores, formation of an embryo-sac, fertilization, and the development of an embryo by the fertilized egg. This manner of embryo formation has not been reported before in Angiosprems. The number of chromosomes in this plant will be reported shortly.

Another feature of interest is that some of the wall cells which are nucellar in nature, and which usually degenerate in the other Orchids, develop, actively divide, and give rise to additional embryos (Figs. 15 to 19). Figure 15 illustrates the degenerating central megaspore-mother cell and the two developing wall cells. Figure 19 shows a group of three embryos, one developed from the megaspore-mother cell (*a*) and the other two (*b* & *c*) from the wall cells. Attempts are being made to germinate these seeds and grow them to the adult size.

Spiranthes is a marsh orchid. How far this course of development which is peculiar to it is due to the ecological conditions is being studied at present.

K. N. SESHAGIRIAH.

Department of Botany,
Central College,
Bangalore,
September 26, 1932.

Albino and White-Striped Characters in Rice.

SELF-POLLINATED seeds of apparently pure green types produce a number of seedlings deficient in chlorophyll. Most of them are entirely chlorotic which soon die in the seed bed, while a few are partially so giving a variegated appearance to the plants with white-striped leaves. The latter survive although in a weak condition and produce normal grains. These chlorophyll abnormalities in individual types are on the whole very few in comparison to the green population therein and especially the white-striped plants which are very rare. Both kinds of chlorophyll abnormalities have been studied by a number of American workers in maize and sorghum, and by Kondo[1] in rice. The albino character has been studied by Ramiah[2] in rice. Kondo observed the albino and variegated characters of the non-Mendelian maternal inheritance while Ramiah noted the albino and pale-yellow seedlings to be Mendelian recessive in character segregating in 3 : 1 and 15 : 1 ratios. In our work the albino seedlings were found to appear in a large number of types ranging from .26% to 20% without showing any definite ratio, the crosses showing an increased percentage than the ordinary pure types as pointed out by Ramiah.

In 1926 three white-striped plants appeared in an apparently pure type in the observation plot at the Government Rice Experiment Station at Titabar (Assam). Both the leaf and grain showed the white-stripes distinctly. Germination tests of seeds obtained from them produced 100% green seedlings in

[1] *Ber. Ohara. Inst. Landw. Forsch.*, **3**, 3.

[2] *Mem. Dept. Agric., India*, Vol. 8., No. 7.

some, whereas 69% green, 23% white-striped and 8% albino seedlings were produced in others. In one case the ratio of white-striped to albino was 3 : 1 showing a fairly good fit. As recessive lethal characters tend to eliminate in time in competition with the normal allelomorphs, we have obtained a pure white-striped type later in two successive generations.

In both natural and artificial crosses the white-striped character segregated in F_2 in 3 : 1 ratio with a good fit and that one pair of factors were involved in them. The F_3 results in both confirmed the same. A heterozygous green plant back-crossed with a recessive white-striped plant gave 17 green: 14 white-striped plants with a deviation of 1.5 ± 1.87 from the expected number of 15.5 in each case. In fact, the white-striped character has been found to segregate as a simple Mendelian recessive to green in natural, artificial and back-crosses.

S. K. MITRA.

Jorhat (Assam).

Peculiar Bisexual Cones of *Pinus longifolia*.

IN my previous paper[1], I described the hermaphrodite cones of *Pinus longifolia* and *Picea morinda*. The features recorded about *Picea morinda* are very rare in occurrence, the only other instance being that of *Abies excelsa*[2] and those about *Pinus longifolia* have not previousjy been recorded. My recent collections contain some peculiar cones of *Pinus longifolia*, a brief description of which is given below. The terminal portions of the cones are occupied as in the normal female cones by a compact group of megasporophylls. Below this zone, on the same axis of few cones, there is a circlet of male cones varying in number from 1 to 10 much smaller than the normal male cones (Fig. 1). However, in some others the male cones are intermixed with female cones ranging in number from 1 to 5 (Fig. 2). These axillary female cones are much smaller than the axillary male cones and the terminal female cone. Below this zone, the axis is covered over by the usual scales and still lower down, bundles of needles appear at the axil of the scales. The development of these cones seems to be quite normal, no physical deformity or disturbance being noticed. Further details of the structure and significance of these cones will soon appear elsewhere.

Fig. 1.

Fig. 2.

L. N. RAO.

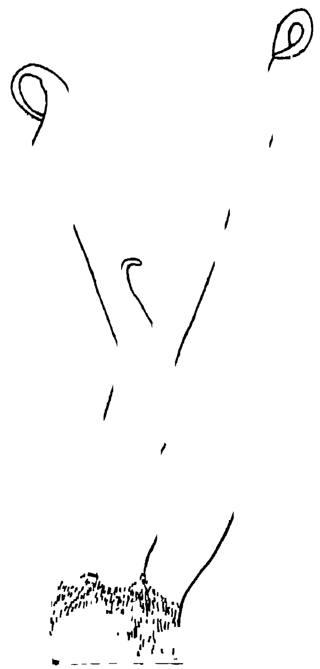
Department of Botany,
Central College, Bangalore,
August, 1932.

[1] L. N. Rao, "Bisporangiate Cones of Pinus longifolia and Picea morinda," *Jour. Ind. Bot. Soc.*, **10**, No. 3, 1931.

[2] Dickson, A., "Observations on some Bisexual Cones occurring in Abies excelsa," *Trans. Edinbg. Bot. Soc.*, **6**, 1860.

Multicarpellary Apocarpous Pistils in *Poinciana regia* Boj.

IN this short note the abnormal occurrence of multicarpellary apocarpous gynaecia is recorded in *Poinc'ana regia* Boj, collected locally by the writer in the first week of August. Several flowers were collected in which the pistil was composed of more than one carpel. One such, from a not very immature flower-bud, is sketched in the accompanying figure, after the removal of



Poinciana regia.
An abnormal pistil showing three carpels.

the sepals, petals and stamens. In the material examined flowers were seen having 2-4 carpels. All the carpels were never of the same size. In many cases, one could make out from the outside a central growing point-like structure and it appears that this goes on forming new carpels laterally in acropetal succession. A detailed histological investigation is on hand and results will be published in due course.

A. C. JOSHI.

Botany Department,
Benares Hindu University.
Benares,
August 18, 1932.

On the Wave-Statistical Theory of Unimolecular Reactions.

IN a previous paper, a relation between the disintegration constant and velocity of α-particles in radioactive disintegration was established by Kar and the author introducing a damping factor in the wave equation. In this paper it is suggested that the reacting molecules first of all absorb energy A—Q where A is the 'activation energy' and Q the heat of reaction such that the decomposed products and undecomposed molecules should be at the same energy level, before spontaneous damping or in the language of wave mechanics, 'austausch' takes place. This is analogous to the familiar activation hypothesis. Considering two regions, $x < r_0$, where damping takes place, and within which the molecules are present as complete entity and a region $x > r_0$, at the boundary of which there is a potential barrier which the resultant products must overcome, the following expressions for the velocity coefficient are deduced:—

$$k_1 \sim \frac{0 \cdot 91}{h} \sqrt{(\mathrm{A}-\mathrm{Q})\,\mathrm{A}}\; e^{-\frac{\mathrm{A}}{k\mathrm{T}}} \quad .. \qquad .. \quad (1)$$

(First approx.)

$$\text{or if } \mathrm{Q} \sim 0, \quad k_1 \sim 0 \cdot 91\, \nu\, c^{-\frac{h\nu}{k\mathrm{T}}} \qquad .. \quad (1a)$$

where $\mathrm{A} = h\nu$

$$\text{and} \qquad \mathrm{A} = exp.^{\frac{\beta\,(\mathrm{Q}-\mathrm{A})}{\sqrt{\mathrm{A}}}}\; e^{-\frac{\mathrm{A}}{k\mathrm{T}}} \qquad .. \quad (2)$$

where β is constant and the damping co-efficient is large. Another alternative expression is obtained for the case when the damping is small in the following form:

$$k_1 \sim .e^{\beta' \sqrt{\nu + \mathrm{Q} - 2\mathrm{A}}} \,.\, e^{-\frac{\mathrm{A}}{k\mathrm{T}}} \quad .. \qquad .. \quad (3)$$

It is to be noted that equation (1*a*) is similar to the expressions of Dushman, Polanyi and Wigner and the author, while (2) is similar to that obtained by Roginsky and Rosenkewitch.[1] The last two expressions involve the distance r_0 indicating that although ordinarily the reaction velocity co-efficient is independent of concentration, modification may take place at very low pressure either by the change of r_0 or diminution of the damping co-efficient on account of the abnormal decrease of density.

A. GANGULI.

Chandernagore,
September 1932.

[1] *Z. Phy. Chem.*, **10B**, 47, 1930.

Research Notes.

Experiments on the Development of the Chick and Duck Embryos cultivated *in Vitro.*

THE latest contribution to our knowledge of the potentialities of an organizer-region of the blastoderm of chick is a paper by C. H. Waddington[1] who during the course of his studies has reached most interesting conclusions as regards the rôle played by the primitive gut, primitive streak and the influence on each other of the germinal layers. The previous workers who adopted the method of isolation, were mainly concerned with the study of self-differentiation of tissues of Fowl embryo which they transplanted to the chorio-allantoic membrane and also by cultivating them *in vitro.* Waddington used the latter method in his study of the developmental mechanics of the early chick and duck blastoderm, especially during the stages between the laying of the egg and the appearance of the head process. The first set of experiments deals with the normal *in vitro* development of the chick and duck and the determination of the location of the organ-forming materials in the early stages of the blastoderm. The explanted embryo of the chick which remains alive *in vitro* for 2 or 3 days, reaches the critical period when the circulatory-organs appear and possibly due to a maladjustment of the beating of the heart and the blood formation in the area vasculosa, the embryo dies. The rates of growth and of differentiation are always slower *in vitro* than *in vivo* and the difference, according to Waddington, is nearly represented by the ratio 1 : 1.5. In his studies on the differentiation of portions of blastoderm, he shows that if a cut is made through the primitive pit or just in front of it, before the appearance of the head process, no embryonic organs are developed in the anterior regions, except a small quantity of neural tissue; if, however, the cut is made just behind the primitive pit, a head and also a thin tail are formed, the latter bearing a medullary plate, somites and a notochord. In the first experiment, chiefly where the blastoderm is cut through the primitive pit, the half behind the cut develops all the axial structures except part of the head. If the embryo is cut a little behind, and well behind as far back as the middle of the primitive streak, it is noticed from Waddington's data, that while in the former case, at least medullary folds arise, in the latter there is no trace of embryonic organs. These experiments of Waddington do not confirm the results of authors like T. E. Hunt, B. H. Willier and M. E. Rawles who in employing the chorio-allantoic technique, found that the hinder region of the primitive streak is not capable of self-differentiation in the absence of Hensen's node. In the second set of experiments designed to test the organizing influence of endoderm in the development of the embryo there were two distinct lines of investigations. Isolated endoderm and epiblast were cultivated for purpose of determining the rôle they played in organ formation. If the endoderm is removed in middle or late primitive streak stages of blastoderms the explanted epiblast is found to possess the power of differentiating a neural plate, somites and notochord though somewhat disturbed from their normal relations. The formation of the notochord, which is usually referred to as endodermal in origin, is to be accounted for by the results of recent work in Vertebrate Embryology according to which, the notochord material originally resides in the epiblast and later becomes invaginated at the primitive pit. The explanted endoderm has not given any definite results, though it was noticed that the yolk endoderm cells from the margin of the disc grew centripetally so as to cover the entire area below the area pellucida. Experimentally, on account of great distortions taking place in the explants and the formation of blisters, it is not possible to ascertain the precise age at which the germinal layers acquire the power of self-differentiation and directional influence. Again for the purpose of determining the nature and extent of mutual influence of epiblast and endoderm, Waddington separated them and readjusted them so that the longitudinal axis of the former was at right angles to that of the latter. The results of the experiment naturally will depend on the amount of healing of the tissues and on the extent of the organic contact between them. In successful preparations, positive results have been obtained. It is found that if the operation is performed on a blastoderm in which the primitive streak is not yet fully grown, the direction of its growth is influenced by

[1] *Phil. Trans. Roy. Soc.*, Series B, **221**, 1932.

the position of the endoderm, *i.e.*, anterior part of the primitive streak, and of the resulting neural folds is bent towards the anterior end of the endoderm while the posterior end of the primitive streak is deflected away from this pole. Waddington points out that the definite deflection of the primitive streak and the neural folds may not be a secondary phenomenon due to the mechanical properties of the tissues, but should be explained on the hypothesis that as in the formative stages of the primitive streak, its axis is determined by the growing endoderm below, this influence of the anterior end of the endoderm is continued to be exerted even under experimental conditions. The endoderm, chiefly at the growing points, has therefore a direct influence on the axial relations of the primitive streak and also those of the neural folds. The continuity of the neural plate without interruption or lesion points to the fact that the neural material is derived only from presumptive medullary material and not from other sources.

The next series of experiments deal with the determination of the nature and scope of the organizing influence of the primitive streak, firstly by testing the inductive capacity of the entire structure and then that of isolated pieces. When two specimens of blastoderm, the underlying endodermal layer having been removed, are opposed so that their ventral faces are in contact and the primitive streaks do not touch their whole length, definite evidence is obtained that the growing primitive streak can induce the formation of a medullary plate in an epiblast with which it is in contact. Waddington further evidences in support of the view that the induced medullary plate is not formed from presumptive neural material which has been prevented from moving to its normal place, by the removal of the endoderm, but the induction is due both to the form building movements and the qualitative differentiation of the cells. To the interesting inquiry whether a medullary plate in these experiments can be induced at any angle to the normal neural plate of the same epiblast, the answer is furnished that they can be induced in any orientation making an angle of 150 degrees. The grafting experiments devised for the purpose of testing the inducing capacity of the primitive streak, either whole or in fragments taken from definite regions, shows that practically all the grafts give rise to a certain amount of mesoderm and as regards the neural tissue, the anterior portions of the primitive streak frequently and the posterior rarely, and the middle pieces sometimes do form. In these experiments, fragments of primitive streak were introduced between the endoderm and epiblast of a blastoderm chiefly through a hole made in the endoderm. If pieces of the primitive streak were cultivated separately they are observed to differentiate to neural tissue, somatic mesoderm, and the injured part of the primitive streak regenerates. If in the process of regeneration the epiblast were considered as a whole, these two organ forming movements, the superficial centripetal and the deeper centrifugal, leading to the adjustment of the tissues, and the capacity for the induction of tissues is possessed by the primitive streak and the labile determination of the presumptive tissues is dependent on the tissue forming movements.

In summarising this piece of extraordinarily interesting work, it was found necessary to follow clearly the different types of experiment in the order in which they have been described and also the language of the author as far as possible in order to sustain the interest of scientific readers.

The Innervation of the Heart of the Crustacea.

[J. S. Alexandrewicz, *Quarl. Journ. Micros. Sci.*, **75**, No. 298, June 1932.]

IN the heart of the Decaped Crustacea three systems of nervous elements can be distinguished: (*a*) a local system of neurons distributed in the heart itself supplying impulses necessary for the regular contractions of the muscles of the heart; (*b*) a system of fibres running from the Central nervous system to the heart, inhibitory and acceleratory in function; (*c*) a system of nerves supplying the valves of the heart holding their muscle fibres in contraction during the diastolic period of the heart. There are also nerves supplying the muscles of the pericardium which are evidently sensory in function.

The Origin and Migration of the Primordial Germ-cells of Sphenodon Punctatus.

[Margaret Tribe & F. W R. Brambell. *Quart Journ. Micros. Sci.*, **75**, No. 298, June 1932.]

THE primordial germ-cells of Sphenodon originate in the yolk-sac endoderm and are

differentiated very early. They are very large in size and are filled with yolk-granules. They migrate through the yolk-sac endoderm and mesoderm by their own amœbeid movements entering the embryo by way of the venous blood stream or by migration through the extra-embryonal endoderm and splanchnic mesoderm. They thus reach the germinal ridges, lose their yolk content and enter the prophase of the heterotypic division.

Sex Reversal and Experimental Production of Neutral Tassels in Zea mays.

[John H. Schaffner, *Bot. Gaz.*, **90**, 3, 1930.]

THE fact of sex reversal has been established for many species of plants, the reversal being brought about commonly in one direction as readily as in the other, *i.e.*, from male to female and from female to male. In the transition from one sex to the other, a physiological state of zero or neutral point must be passed through. This transition neutral condition is interesting on account of the characters developed in the tissue. For example, monœcious or diœcious species frequently develop bisporangiate flowers on the neutral zone, others develop sex mosaics, rudimentary flowers or peculiar vegetative structures. The author concludes that by simple control of environmental conditions vestigial tassels can be produced in Zea mays at will, the natural photoperiodic gradient extending from August to November, producing sometimes 40% or more of neutral tassels in a lot. The following general types of tassels can be developed by proper photoperiodicity, staminate, carpellate and neuters and four sex mosaics—staminate neuters, carpellate neuters, staminate-carpellate and staminate-carpellate-neuters. With the decreasing photoperiodicity, femaleness is only expressed at the base of the tassel, the top being neuter and the middle region staminate. With the increasing photoperiodicity, femaleness may also be expressed at the top of the tassel and its branches, or sometimes forming sex mosaics. Even pure lines react to photoperiodicity in the same way as commercial heterozygous varieties giving rise to complete sex reversals and all possible types of sex mosaics. Male expression can be suppressed completely in the monœcious Zea mays when it is grown in a decreasing photoperiodic environment of suitable length. The specific sex condition developed is independent of any balance of sex determining or sex producing genes. It is obvious that genetic experiments involving sex conditions are of no value unless the reactions obtained are interpreted in the light of ecological conditions present.

Nature and Development of the Tracheids of the Ophioglossaceæ.

[Gasper A. Luharidge, *Bot. Gaz.*, **98**, 2, 1932.]

THE object of the study has been the tracing of the development of the tracheids of the Ophioglossaceæ, since tracheids are unusual for ferns, in that they bear on their walls distinct bordered pits resembling those characteristic of many of the higher plants, instead of scalariform markings characteristic of Filicales. All the three genera of Ophioglossaceæ are considered. Fresh material was fixed in Jeffrey's corrosive sublimate and picric acid, alcohol-formalin, and alcohol-formalin-acetic acid. All material was treated with 10% Hydrofluoric acid for a week to remove traces of silica. Erythrosin and crystal violet, safranin with crystal violet and hæmatoxylin (Ehrlich's and Heidenhain's) were used. Combination of foast-green and safranin gave excellent differentiation of the three regions of the wall. The terminal buds in most species of Ophioglossaceæ consist of a series of three to five leaves, one of which reaches maturity each year. The rate of differentiation and maturation of tracheids is rapid and takes place just behind the apical region of the stem, the transition region being very short. The differentiation and maturation of the leaf-trace is very slow, this being attributed to the rapid growth of the leaf and the consequent extension of the region over which differentiation takes place, whereas the stem, being less conservative, crowds the transition region to a short space. Lignification and maturation of tracheids begin in the leaf as early as four years before the leaf reaches maturity. The secondary thickening differs from that of the Spermatophytes in being made up of cellulose and the tertiary thickening of lignin, which covers the secondary thickening and forms bordered pits.

A Marine Biological Station in Bombay.

By S. B. Setna, M.Sc., Ph.D. (Cantab.),
Royal Institute of Science, Bombay.

THIS subject has been so fully discussed in the lay press that some apology may, perhaps, be necessary for the present note. The only excuse is that by repeatedly harping on the subject of "Marine Biology for India," we may at last expect the realization of the wants of Indian Biologists. Apropos of this, it would not be out of place to refer to Professor J. Stanley Gardiner's view, "That the great deficiency of all my Indian research pupils, however brilliant their university careers have been, is their lack of understanding of what life really means and how living matter reacts. They have read well but the proper understanding of Biological questions is bound up with the study of living animals. It is the custom here and in every country of Europe to send their high grade pupils to marine stations for study and of these I recall 15 in Western Europe to which I have at times sent pupils. They keep animals alive and study them, make experiments on them alive by altering the temperature of the water in which they live, the kinds of salts in the same, varying the conditions of light, etc. In America they are even stronger on the necessity for such visits than we are, regarding scientific training incomplete without them. Egypt at the present moment is erecting its marine station at Ghardaga on the Red Sea, regarding it as a necessity for its students. I do hope Bombay will give its students a station too."

From my personal knowledge, I think that there can be hardly a more suitable site for the establishment of a marine biological station than Bombay. The faunistic conditions of the waters near Bombay are fairly good. It is surrounded by the sea on all sides. The most important feature that should commend itself in the choice of a site, is the existence of a university on its littoral. As a railway terminus and junction, Bombay is equidistant from almost all the leading centres of biological investigation in India. Being within easy reach of most university towns in the country, it is not an idle expectation that the distinguished zoologists, who staff these institutions, will visit Bombay for a study of marine problems and that the proposed station will ultimately justify its existence.

We may now turn to discuss briefly the effect of the establishment of such an institution, its necessity for a proper understanding of zoological problems and its utility to commerce. A well-conducted Marine Biological Station will first enable the country to systematize its fisheries which at present are largely conducted on obsolete, unscientific, crude and wasteful methods. In respect of its fisheries India obstinately clings to habits which are now generally discarded. Modern methods and up-to-date scientific appliances which are in universal use in the West have not yet been adequately availed of here. In matters relating to the application of science to industry our country is hopelessly behind the times.

The value of fisheries as source of income to the country's revenue may be gauged from the fact that in Great Britain in one year alone, and that too a long while back when the fishing industry was still in an experimental stage, nearly a million and a quarter tons of fish were landed. Its value at the port of landing was computed to be £15,000,000 as compared with £13,000,000—the value of one and a half million tons of wheat grown in the same year. Since then the yield from the British fisheries has almost trebled in value. Aware of this, almost all countries in Europe situated on the sea board have made vigorous efforts to develop their marine sources of wealth. Turning to India what do we find? A distressing tale due solely to lack of enterprise and tardiness to give encouragement when the initiative has been taken. It is most disheartening to find that in India almost no effort has as yet been made to develop the almost inexhaustible resources that are lying so plentifully at our very door-step.

At present almost all the fishery work in India is haphazard and unscientific. Our fishermen—and even we people with scientific training—know practically next to nothing of the migratory instincts of the fishes they are in quest of, of their haunts and spawning grounds. Similarly, they have next to no knowledge of the movements, direction and rate of the currents, the temperature of the water, the nutrition taken by sea creatures and countless other physical and physiological factors. Both from strictly scientific considerations and in the interests of fishermen, it is of vital importance to collect the maximum data relating to fishes and their conditions of life and this not in the present empirical fashion, but with a scrupulous regard for the verification of every piece of information by scientific observation and experiment.

It is tragic to find that the study of Biology in Indian universities is a travesty of what is implied by that term and is a study of not life, but of death, for most of the specimens which form the subject of laboratory work, are dead. The anomaly does not end here and it is a curious reflection on our methods of organization and study that even in the case of a large number of dead specimens, the majority of them come from Europe. Could anything be more absurd than that this so-called study of Biology should relate to creatures that our students have no opportunity of seeing and of whose real life habits they can know nothing? It is no Biology, but hearsay. It is high time this farce ended and that such unscientific training of our students was revealed in its naked reality.

Of the various institutions, which combine both pleasure and instruction, it is difficult to conceive of anything more attractive than a well-organized marine biological station with its aquarium. The marine biological station, if efficiently maintained, will display a large range of marine fauna. On payment of a small charge the aquarium could be open to the public as a sort of museum. The revenue thus derived could be devoted to the establishment charges. That the income from this head is likely to be large may be gathered

from the case of the Madras aquarium which gets an annual revenue of about Rs. 10,000 on an average. Bombay is far more thickly populated than Madras. More people visit Bombay and as a centre of commerce and trade it has a large floating population, which will add very largely to the revenue; it is therefore to be expected that the annual income from the Bombay station will exceed that of Madras by several thousand rupees. Taking a moderate estimate I should put it down to at least about Rs. 15,000 per annum.

I am of the opinion that a small start should be made at the beginning. The local Government, it is understood, has been moved to grant gratis a site for the location of the station. A miniature laboratory would be enough in the early stages. A library is an expensive but an indispensable requisite, but this may be overlooked as the Royal Institute of Science has a fairly good collection of books bearing on the subject, and its library may be availed of by students working at the station. This will be a great saving as far as a very important feature of the station is concerned.

The income of the station will be derived from :— (1) admission charges to the aquarium, (2) supply of marine specimens to places inland, (3) rental of tables. A unique feature of the European stations is the table system of support. The stations have a number of tables and undertake to provide research privileges for any institution or person who books a table for a whole year. The above three heads do not exhaust all the sources of revenue. Other likely heads of income are grants from the Government, universities in India, the local Ministry of Agriculture, the Bombay Natural History Society and, last but not the least, donations from public-spirited and generous citizens. But all these sources of revenue will only go to the maintenance and upkeep charges. The main problem is the initial expenditure for founding the station. For this a sum of at least Rs. 1,00,000 is needed, the whole amount being absorbed in meeting the expenses of the erection of the building and the provisions of just the ordinary equipment and essential apparatus for investigation.

What is now urgently needed is the energetic and wholehearted co-operation of all the universities in India to make this suggestion a reality, for it is the universities and their countless throng of students who will ultimately derive the maximum profit from the station. The absence of such a station is a lacuna in our scientific organization, the existence of which we should not allow to continue a moment longer.

We earnestly hope that the cause for reproach on this score will be wiped out in the immediate future.

The Late Colonel Sir Ronald Ross, K.C.B., K.C.M.G., F.R.S., LL.D. (1857-1932).

THE great pioneers of tropical medicine are rapidly leaving us; Manson has gone, Laveran has gone and now Sir Ronald Ross has been taken from us.

The strides which have been made in the investigation of tropical diseases, since Laveran discovered the malaria parasite in 1880, have probably been greater than in any other branch of medicine. The majority of this development has taken place since the epoch-making discovery by Ross in 1897 that malaria was carried by the mosquito.

One will always associate the science of malariology with the name of Ross. If one considers the statement of that great physician, Osler, that "if a census were taken among the world's workers on disease, the judgment to be based upon the damage to health and direct mortality, the votes would be given to malaria as the greatest single destroyer of the human race", it is not then too much to say that Ross' discovery was one of the greatest, probably the greatest, made in medicine in the last half century. It has saved innumerable lives and has made practicable the development of large areas of the tropics which were previously uninhabitable.

Every worker in tropics, be he trader or missionary, soldier or sailor, engineer or doctor, miner or agriculturist, owes a debt of gratitude to this great scientist. India with her estimated death rate of one million per annum from this disease, is especially indebted to Sir Ronald Ross, whom she can proudly claim as especially her own, for he was born at Almora in the Kumaon Hills on 13th May, 1857, of a family with many associations with this country. He spent 18 years as an officer of the Indian Medical Service and it was in India that he made his great discovery.

Sir Ronald Ross received his medical education at St. Bartholomew's Hospital and entered the Indian Medical Service in 1881. His early inclinations were towards literature and mathematics, but he did not neglect his profession, for he was one of the first medical men to take the diploma in Public Health.

His interest in malaria commenced early in his Service and he was awarded the Parke's Memorial Prize in 1895 for an essay on malaria. In this he put forward evidence against the generally accepted theory that the disease was caused by miasma arising from swampy areas. It was at this period that he came in contact with Sir Patrick Manson and, as a result, returned to India full of enthusiasm about research work on malaria. His chief object was the investigation of the theory that mosquitoes were responsible, in some manner, for the spread of malaria, a hypothesis which had been suggested in 1883–84 by King, Laveran and Koch and of which Manson was a strong supporter.

When Ross commenced his work, medical protozoology and medical entomology were in their infancy. No one had even dreamt of the amazing cycles of development which protozoa may undergo in insect hosts, and, except for the discovery made by Smith and Kilborne in 1893 that bovine piroplasmosis was transmitted by the tick, the transmission of protozoal diseases by arthropods was unthought of.

It was on such an uncharted sea that Ross embarked on his return to India in 1895. Through 2½ years of unceasing toil, hampered by heart-rending disappointments and technical difficulties, with indomitable perseverance he struggled on, sustained by the counsel and sympathy of Sir Patrick Manson. About noon on 20th August 1897, in the heat of an Indian summer he saw for the first time the oocyst stage of development of the human malaria parasite in the Anopheline mosquito, and thus opened up a new era in the history of disease transmission.

At this time military duties interrupted his work and not until the following year, when he was placed on special duty at Calcutta, had he an opportunity of completing his research. In July 1898, he was able to telegraph to his friend, supporter and confident, Sir Patrick Manson, that he had proved the mosquito cycle of the malaria parasite by his experimentation with bird malaria and *Culex*. The details of the developmental cycle which he described stands to-day practically unchanged. A Gate of Commemoration was erected at the General Hospital, Calcutta, in 1927, in memory of the discovery and within a few yards of it stands the small laboratory in which the final results were obtained.

Although Ross sometimes spoke of the luck which attended his great discov one cannot but think that a lesser man possessing his grit, energy, determinat and ability, would have given up in des before the enormous difficulties which b his path.

Sir Ronald Ross left India in 1899 was quicky appointed to a teaching pos the newly-formed School of Tropical M cine in Liverpool. While in this post took part in many expeditions to tropics in connection with malarial inve gation and prevention. The chief of t were to the west coast of Africa, to Isma to Greece and to Mauritius.

There was no branch of malariol which has not felt his influence. Du the 13 years in which he was at Liver he taught and inspired many workers, only in connection with malaria but relation to many other tropical diseases.

At the outbreak of the Great War acted as Consultant in Tropical Disease the Army with the rank of Colonel. visited Egypt and Salonika in this capa and was on a ship which was torped After the War he was appointed Hono Consultant in Tropical Diseases to Ministry of Pensions.

Some years later a public subscrip was started which resulted in the four tion of the Ross Institute for Trop Diseases at Putney Heath. This was augurated by H. R. H. The Prince of W on 15th July, 1926, with Sir Ronald I as Director-in-Chief.

Unfortunately he had a paralytic sei in 1927, but even this did not stop unbounded energy and he continued work, more especially in his mathemat studies, until a few months before his de

Although he will always be rememb for his medical researches, yet his work pure mathematics and pathometry, n especially in relation to malaria, was high order. His scientific achievem have won for him world-wide fame have overshadowed his work in the f of art. He was not only a musician a novelist and a poet. Indeed at one t he seriously contemplated abandoning m cine for literature. Of his poetry Mr. J Masefield, the Poet Laureate, has spoke most eulogistic terms.

Sir Ronald was always a staunch fri and an enthusiastic helper to rese workers who consulted him. The camp for improving the emoluments and for

state endowment of research workers received his strong support.

Sir Ronald Ross was made F.R.S. and F.R.C.S. in 1901. He was decorated C.B. in 1902, K.C.B. in 1911 and K.C.M.G. in 1918. His great discovery gained him the Nobel Prize for Medicine in 1902 and very many Governments and Universities have awarded him honours and degrees in recognition of the great benefits which his discovery has conferred upon humanity.

J. A. SINTON, LT.-COL

The Industrial Outlook.

Crisis in the Lac Industry.

By M. Sreenivasaya.

THE Indian lac industry is at the moment passing through a crisis which may be regarded as a logical consequence of the shortsighted policy pursued in the past. The prevailing general trade depression, common to all countries and industries, does not fully account for the increasing decline in prices for lac, and therefore, in this instance, there is not the same hope of a satisfactory recovery when trade conditions improve. Other factors, far more serious and subtle, now merged in the present trade slump, have been silently working during many years, while those responsible for maintaining the industry have not sufficiently anticipated the danger now confronting it.

The lac industry owed its brief prosperity exclusively to scientific developments in Europe and America. Before the advent of the gramophone the demand for lac was very limited, being utilized in a few of the finishing industries. In its very early days, lac was valued more for its scarlet dye than for the resin, and German synthetic dyes soon ousted this natural product, not because of superior fastness or brilliance but by their ready availability to fabrics without elaborate processing. The lac dye lost its market through dearth of economical manufacturing methods, and to-day its significance is only historical.

At that period in this country the resin had a few uses each indicating the potential nucleus of a big industry. Bangle-making could have grown into the moulding trade, later developed in the West: the lacquer industry could have been built up into the manufacture of lacquers and lacquer-enamels for metal and wood; but there existed neither the atmosphere nor the urge to elaborate industries based on the utilization of indigenous raw materials.

The industrial revolution wrought a transformation in the economic life of the Western nations; it gave an incentive into their inventive genius which, in turn, stimulated a greedy hunt for new raw materials from all parts of the globe. India, with her vast wealth and variety of unexploited raw meterials, generously responded to the call. Lac was one of the important raw materials whose production was greatly enlarged by the industrial developments in the West. The expansion of the electrical industry in America, the gramophone industry and the development of the finishing industries in general built up a steady demand for lac. In course of perfecting and rationalizing these industries, lac was subjected to rigorous tests and found wanting. Shellac as a plastic or as an ingredient for moulding compositions did not meet the exacting requirements of certain industries; for instance, although a good electrical insulator at ordinary temperatures, it cannot withstand high temperatures. The demands of industry grew more discriminating and rational, which in turn necessitated the control of the raw material from the very origin of its production. The lac industry was in a primitive state of organization. Frequent failures and uncertainty of crops led to violent fluctuations of the shellac market, which gave the exporter ample opportunity to speculate, thus doing more harm to the industry than any other single factor contributing to its present downfall. There was then no organization in the country to standardise the various lac brands, and ensure that reasonable uniformity of composition which the rationalized industries demand. Uncontrolled and greedy adulterations practised throughout the country brought down the reputation of the product and led to a rigorous system of analysis by the consumer. In short, the Indian industry did not cater sympathetically, intelligently and honestly for the needs of foreign consumers who were driven in disgust to search for synthetic substitutes

fully capable of control. It is the same spirit which induced some of the American manufacturers to lease out their own estates and forests in India for purposes of lac production.

American revolt against the shellac trade tyranny dates from 1910, because it is during this year that L. V. Redman began his investigations of the action between phenols and aldehydes under the auspices of the Mellon Institute. This intensive study, occupying three years, bore fruit in the commercial manufacture of "Redmanol". At the same time, the analogous product called "Bakelite" had been developed by L. H. Bakeland. Later these two processes were amalgamated with such fruitful results as have been witnessed during the last decade and a half. The synthetic resins have played an important part in all recent technological progress. The variety of synthetic resins now available is so great that there is a resin suitable for any rigorous specification that may be imposed. The chemistry of resin manufacture is so advanced and the properties of a material so controlled, that the specific needs of any new industry may be met. Although the synthesis of a resin identical with shellac has not been achieved, the products have advantageously displaced shellac in many of the industries. High temperature electric insulation, infusible mouldings, oil-soluble resins, compositions of varying plasticity, hardness, elasticity, colour and transparency have been rendered possible through the wide range of resins that have been revealed. The synthetic resins are not only displacing the natural products, but have also extended their field of usefulness and have stimulated the development of new processes and manufactures. For example, cellulose base plastics and quick-curing resins have entered the field of gramophone-record manufacture, and novelties in the form of flexible records are forecasted through the employment of these new plastics.

Shellac occupied a prominent position among the raw materials of the finisher and the varnish-manufacturer. The advent of pyroxylin and cellulose acetate in the year 1922 into the field of lacquers attacked both lac and the drying oils. The phenomenal development of the lacquer industry in America since 1923 is doubtless due to the industrial production of cheap solvents made possible through (1) evolution of the butyl alcohol fermentation process and (2) high pressure catalytic synthesis of alcohols. The mass production of automobiles called for quick drying lacquers adapted to rapid spray painting, in place of the old oil varnishes which require to be heat-cured or baked for long hours. The lacquer and lacquer-enamel investigation has been so ardently pursued that the days of oil-varnishes in the linseed class are numbered, their place being taken by partially polymerised synthetic resins. The technological success of these pyroxylin lacquers has been so great and convincing that American railway rolling stock has been painted with them and the total consumption of pyroxylin for lacquers in the year 1929 was 41 million gallons.

In the lacquer industry, shellac, as the chief ingredient of spirit varnishes, has lost its pre-eminent position and is now subordinated to lending gloss, brilliance, hardness with water-proofing and adhesive qualities to the pyroxylin finishes.

Intercommodity and interprocess competition has adversely influenced lac because of high and unsettled prices, variable composition, and incapacity to meet some of the new needs. In 1924, America overproduced synthetic resins and the essential raw materials, of which America has now made herself independent of foreign import. This is a serious situation which gives little hope of recovery for the shellac market, since America would naturally strive to utilize her home-made and abundant synthetics to her best advantage, in preference to shellac which she has to import. If the American demand, which still accounts for sixty per cent. of the trade continues to decline, the lac industry will have to face a ruinous crisis. During the last few months, shellac has found a few new markets in Europe, but compared with what it stands to lose in America, these are negligible.

The remedy to this threatening situation lies not in propaganda in foreign countries extolling the virtues of our raw material but in building up indigenous industries which will consume it in our own country. When Japan's camphor industry was threatened with severe competition from German synthetic camphor, Japan immediately organized her national industry and founded a trust to control the prices. When she found that the economic price could no longer be maintained, Japan founded the celluloid industry which consumes a considerable

part of her natural product. India should now adopt a similar policy with respect to the lac industry. The spirit lacquers and lacquer enamels which consume shellac as the principal ingredient should be manufactured. Intensive research work will have to be undertaken to discover suitable solvents and plasticisers which will impart to the shellac film the desirable qualities of gloss, hardness, resistance to water and to other forms of chemical action. The solvents of shellac as compared with those of cellulose esters are far cheaper and are at present available in large quantities in the country; if necessary, their output could be increased.

The use of shellac could be extended to the manufacture of certain types of mouldings which need not be exposed to high temperatures. Many of the electrical appliances, switches, plugs, etc., with dials, stands and other artware could be manufactured. Much research is required to elucidate the fundamental physical and chemical properties of shellac before we can think of other appropriate uses. In the meanwhile a beginning can be made on the lines indicated.

To encourage exploitation of new uses for shellac, research fellowships and prizes should be founded on a liberal scale in the country and in this matter the Government should help the industry. The Rubber Growers' Association launched a similar scheme a decade ago, as a result of which 10,000 suggestions were put forward for novel uses of rubber. The technology and industrial applications of rubber have benefited immensely as a result of this scheme which has no doubt greatly stabilized a trade at present suffering from overproduction. The Imperial Council of Agricultural Research should immediately take this matter in hand and investigate a situation which bears heavily on the economic prosperity of the country.

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Effect of Ionization on Impregnated Paper Insulation.

(*Electrical World*, July 30, 1932, Vol. 100, 5.)

MR. K. S. WYATT, Research Department, Detroit Edison Co., has experimentally shown that if ionization occurs in an operating cable, the impregnating compound itself may deteriorate and increase considerably in dielectric loss. The deterioration products may not be uniformly distributed throughout the cable, but may be concentrated in spots which conceivably might factor in breakdown. The modified Becker cell used in the investigations appears to be an effective tool with which to investigate the influence of Corona discharge on the dielectric loss characeristics of insulting oils and papers.

Science News.

WE have pleasure in acknowledging with sincere and heart-felt gratitude, the generous donation of Rupees Five Hundred granted to the "*Current Science*" Funds by the Senate of the Madras University for 1932-33. May we not hope that this shining example of Madras to uphold and advance the cause of Science in India will be promptly followed by the other Universities?

* * *

In an extension lecture of the Allahabad University, Prof. A. C. Banerji, M.A., M.Sc., addressing on "Modern Science and its influence on some of the Philosophical ideas of the present century", outlined the far-reaching changes brought about in man's outlook of the Universe by modern theories of physical science. The age of the mechanical scientist is gone and the quantum theory, atomic theory and relativity have replaced the law of causation and determinism, whereby Nature could only follow one path, *i.e.*, the road mapped out for her from the beginning of time to its end, by the Law of Probability and Uncertainty. There is no real distinction between aspects of matter or light. It is a case of the principle of duality as suggested by C. G. Darwin. According to the Heisenberg's principle of indetermination, it can no longer be asserted that a complete knowledge of the present would make it possible for us to predict the future with certainty.

Discussing the theory of the expanding Universe as suggested by LeMaitre, DeSitter and Eddington, Prof. Banerji said that it is possible to reconcile the age of the Universe as calculated by Eddington and as obtained from Astronomical and Geophysical evidence by assuming that the reddening of Spectral lines was due to gravitational effect as postulated by Zivicky.

* * *

The following papers were read before the U. P. Academy of Sciences, Allahabad, on the 6th of August 1932:—

1. "On a Generalized Formulation of Trouton's Law". By Mr. Satyendra Nath Ray, M.Sc., Lucknow.
2. "A generalization of a well-known theorem" (Vivanti-Borel-Dienes Theorem). By Dr. T. Vijayaraghavan, D.Phil., Dacca.
3. "On the absorption spectrum of some higher oxides". By Mr. A. K. Dutta, M.Sc. & Mr. P. K. Sen Gupta, M.Sc., Allahabad.

4. "Post dissociation radiation from SO_3". By Mr. A. K. Dutta, M.Sc., Allahabad.
5. "Absorption spectrum of irradiated iodine". By Mr. G. R. Toshniwal, M.Sc., Allahabad.
6. "Classification of lines of Cl_{IV} and Cl_{V}". By Mr. Suresh Chandra Deb, M.Sc., Allahabad.

* * *

Pandit Madan Mohan Malaviya, Vice-Chancellor, Benares Hindu University, Benares, has been elected a Honorary Fellow of the Academy for his eminent services in the cause of Science and Education. It has been decided to elect four additional Fellows of the Academy.

* * *

Addressing the South Indian Science Association on "Ordinary and Alloy Steels", Mr. D. V. Krishna Rao, Metallurgist, Bhadravati Iron Works, referred to the importance of the Iron and Steel Industry quoting the words of Sir George May, "We are satisfied that the maintenance of a prosperous Iron and Steel Industry in the highest degree of efficiency is essential to the economic progress of this country, while from the point of view of national security it must still be regarded as vital. We accept, therefore, the preliminary proposition that this industry shall be adequately protected and protected at once."

Reference was made to the experiments conducted at Bhadravati in a small Bessemer Converter and an electric furnace. Experiments on ferrochrome conducted at Bangalore showed the great possibilities of ferrochrome in the manufacture of alloy steels.

* * *

Mr. S. S. Patwardhan writes to inform us that he is engaged in the investigation of the anatomy of the common fresh water prawn occurring in Nagpur. He has completed the study of the external characters and parts of internal anatomy and hopes to be able to publish a full report of his researches at an early date.

* * *

H. H. The Maharaja of Travancore Curzon Prize for 1932, of the value of Rs. 500, has been awarded by the University of Madras to Mr. S. Ranganathan, B.A., M.Sc., A.I.I.Sc., Nutrition Research Laboratories, I.R.F.A., Coonoor, for his thesis entitled: "Urinary Calculus — A Problem in Physiological Chemistry."

* * *

We have received one of the Chemical Slide Rule No. 33 manufactured by Albert Nestler AG. The Slide Rule is intended for the use of students of chemistry and besides multiplication, division, evolution and other features of ordinary Slide Rules, it enables special chemical calculations such as analysis, gas reductions, strength and efficiency of currents, etc., by means of molecular and atomic weight scales. We have found the Slide Rule very handy in the laboratory and recommend it to all research workers who have any calculations to make. The Slide Rule is priced at Rs. 10 each and can be had from the Indian Agents, Messrs. M. N. Gokli, Matunga, Bombay, whose advertisement appears elsewhere in this issue.

* * *

The Microid physical series of apparatus illustrated and described in Catalogue No. 115 of Messrs. Griffin and Tatlock, Ltd., England, is indeed a marked advance in laboratory supplies. Not only are the apparatus, many of them of substantial and original design described, but the actual experiment and calculations of results obtained are set out. This is a very welcome feature that should go a long way to popularize these range of apparatus in many laboratories. The apparatus described covers a whole range of subjects simplified, mechanical equivalent of heat apparatus, precision expansion apparatus using invar supporting rods. The thermo-magnet, magnetic potentiometer, refractometer are some of these interesting apparatus which every laboratory worth its name should have.

* * *

We acknowledge with thanks the receipt of the following:—

"Quinquennial Review on the Progress of Education in India", Vols. 1 and 2, 1922-27. Government of India Central Publication Branch, Calcutta.

"Annual Report on Education in India", 1929-30. Government of India Central Publication Branch, Calcutta.

"India in 1930-31", Director of Public Information, Simla.

"Indian Forester", September 1932.

"Scientific Indian", September 1932.

"Journal of the Chemical Society", Vol. IX, No. 1-7, January—July 1932.

"Journal of the Indian Mathematical Society", Vol. XIX, No. 9.

"General Catalogue of Standard Works", Charles Griffin & Co., Ltd., London.

Catalogues of Messrs. Carl Zeiss, Schott & Gen, Jena, Hartmann & Braun AG Frankfurt, from Messrs. Adair Dutt & Co., Ltd., Calcutta.

Catalogue No. 115X—Microid Physical Series from Messrs. Griffin & Tatlock, Ltd., Calcutta.

Reviews.

Palæontologia Indica, New Ser., Vol. XVIII. The Fossil Carnivora of India. By G. E. Pilgrim, D.Sc., [illegible] Pp. iv+232+10 plates. (Calcutta: Geological Survey of India, 1932.)

Compared with the wealth of [illegible] species belonging to the other [illegible] mammals which occur in the Upper [illegible] freshwater deposits of India, [illegible] vora are rather [illegible] formation. The first notice of the fossil remains of carnivorous mammals from the Siwalik deposits of India appeared just over a century ago from the well-known collectors of fossil vertebrate remains, Falconer and Cautley. In 1880, Mr. P. N. Bose described some types of Siwalik cat, hyæna and dog [illegible] the original collections in the British [illegible] and in 1882, Lydekker wrote a mono[illegible] in which he described all the known

Siwalik and Narbada carnivores. Our knowledge of the Siwalik mammals in general, and of the carnivores in particular, has since then been considerably enriched by the work of Dr. G. E. Pilgrim, who has, since 1910, assiduously and systematically collected from the well-known ossiferous deposits developed in the Salt Range area, the Hosiarpur and Kangra districts and from Bugti Hills of Baluchistan. The results of his work have been published in the *Palæontologia Indica* in a series of memoirs on the Giraffidæ, the Suidæ, the Primates, the vertebrate fauna of the Bukti Hills and the Eocene Perissodactyla from Burma. The present memoir on the Carnivora is by no means the last, for one on the Cavicornia of India is under preparation.

Dr. Pilgrim's present contribution forms a valuable summary of our knowledge of the Siwalik Carnivores, of their affinities, inter-continental migrations, lines of descent and suggested phylogenies. It is unfortunately true that a large part of the fossil material embedded in the Siwalik formation suffers from an unsatisfactory mode of preservation and generally is of a highly fragile and fragmentary nature; the discovery of complete jaw-bones, skulls and even of perfectly preserved limb-bones being rather rare events. This is happily not strictly the case with the collection described by Dr. Pilgrim in the memoir under review, for there are fourteen skulls (though only two are figured here) in various degrees of completeness, together with a fair number of maxillæ and mandibles, though, as usual, the greater part of the material available for study is in the form of molars, premolars and canines, either loose or embedded in small fragments of jaw-bones. It must have needed a wide knowledge of anatomical and morphological details to attempt to reconstruct the dentition and the cranial features of the extinct owners of these fragmentary relics.

Only two Creodont species (primitive, ancestral carnivores) have been found, preserved in the Chinji stage of the Lower Siwalik; the rest of the large number of species described here belong to the modern living families of Canidæ, Ursidæ, Mustellidæ, Viverridæ, Hyænidæ and Felidæ, occurring, for the most part, in the Dhok Pathan (Pontian) stage of the Middle Siwalik or the Pinjor (Upper Pliocene) stage of the Upper Siwalik. The earliest Indian carnivores hitherto discovered come from the Gaj series (Burdigallian stage) of the Bugti Hills. These are ascribed to three species belonging to the primitive cats and dogs.

The Hyænidæ are well represented in the Indian region in the later Tertiary deposits and the occurrence of at any rate certain branches of the family at an earlier horizon than is the case in Europe, sheds some light on the lines of descent. The author gives a suggested phylogeny of the hyæna family from the time this group branched off from the Viverridæ.

The plates, reproduced from photographs and drawings by the Geological Survey of India, are of the usual standard. There is an excellent bibliography and a palæontological index.

D. N. W.

* * *

Fundamentals of Biology. By A. W. Haupt, Ph.D., University of California. Pp. x, 403. (McGraw Hill Book Co., Inc., New York and London.) Price 18*s*.

Prof. Haupt in bringing out his second edition of *Fundamentals of Biology* richly deserves congratulations, for it serves as a guide not only to the student of Biology in the College classes but to every public-minded citizen as well. It is generally accepted that in the discharge of one's civic responsibilities one ought to have a sound biological mental equipment which alone can give the right perspective to one's duties and obligations. The object of this book is two-fold. It aims at the cultural development and at the same time provides a large variety of useful and correct information to students preparing for examination. In the earlier chapters the book deals with the morphological characters of the lower and higher animals and plants. Two chapters are devoted to a consideration of the invertebrates while in a further chapter the frog is chosen as a type for a detailed treatment as an introduction to vertebrate morphology. Cursory references to the other groups of the vertebrates are also made. We should have certainly liked a more comprehensive account of the mammals and also a good account of any social insect,—the ant or the honey bee,—for, possibly from one of these well-organized societies, man draws his inspiration for communal life.

The chapters on general principles of Biology, such as heredity, the Mendelian principle and the facts and causes of Evolution,—form valuable and readable additions

to the book, in which the author has endeavoured to give a very clear and comprehensive idea of these very interesting facts of Biological Science. Palæontology, that branch of Biological Science which is most essential for its complete understanding, is treated with great clarity and conciseness. The history of the ancestry of man forms a fit concluding chapter to this excellent book. The illustrations, we are glad to mention, are carefully chosen and excellently reproduced. The style of presentation leaves nothing to be desired. We are of opinion that the book can be used with considerable advantage by students studying Biology and we should recommend that it may be added to the libraries of all secondary schools and colleges.

L. S. R.

* * *

The Pelecypoda of the Siboga Expedition. By B. Prashad, Zoological Survey of India. (Monograph LIII*c*, 334 pp., 9 pls., Leiden, 1932, with a chart of the track of the "Siboga" Expedition.)

The present work is the last of the series dealing with the Bivalve molluscs of the Indo-Pacific seas collected by the "Siboga" Expedition under the leadership of Dr. Max Weber. It includes a more or less complete systematic account of all the families of Pelecypoda except the Pectinidæ. Out of over 400 species and varieties of Bivalve molluscs brought back by the Expedition nearly a fourth represents the forms new to Science which are carefully described and their affinities with known forms are indicated. The excellent photographs and drawings illustrating the salient features of not only the new forms but also of the little known species leave nothing to be desired. The exhaustive synonymic lists and the notes on the distribution and affinities of known species add greatly to the value of the work. There is also a useful index of genera and species at the end. The author deserves the thanks of all students of marine Pelecypoda for an important work of reference on the Indo-Pacific forms.

H. S. R.

* * *

The Tailless Batrachians of Japanese Empire. By Yaichiro Okada. (Imperial Agricultural Experiment Station, Tokyo, Japan: 1931). Pp. 215, with 29 plates and 97 text-figures.

Dr. Okada's memoir is one of the most beautifully illustrated publications on Batrachians published in any country. The author in addition to describing in great detail as many as fifty-nine species and sub-species of tailless Batrachians which occur in the Japanese Empire, has discussed in some detail the geographical distribution and the faunal elements in the Batrachians of Japan. Further, in addition to the descriptions of the external characters of the different species, detailed accounts about skeletal peculiarities are also included in the memoir.

B. P.

Coming Events.

South Indian Science Association.

(CENTRAL COLLEGE, BANGALORE.)

21st Oct. 6 P.M.
"Liquid Air", by Mr. G. Gundu Rao, M.Sc., A.I.I.Sc., Indian Institute of Science, Bangalore.

31st Oct. 6 P.M.
"The Development of the Modern Transformer", by Mr. Vokkaleri Rama Rao, B.Sc., Transformer Expert to the Government of Mysore.

11th Nov. 6 P.M.
"Ancient Hindu Astronomy", by Mr. K. Amrita Rao, M.A., L.T., Librarian, Indian Institute of Science.

Errata.

"*Current Science*", *Vol.* 1, *No.* 2, *August* 1932.

Page 36, Column 2, Line 21, *for* "Latin Square Method" *read* "Checker-board Method".

Page 38, Column 1, Line 47, *for* "decrease" *read* "increase".

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CONTENTS

The Fiftyfive-Year Rule.

THE fundamental rules relating to the age of retirement of public servants are obviously empirical and operate unevenly within the limits of even a single branch of service. In the case of the higher posts in the judicial department and cabinet, the fiftyfive-year rule is relaxed, while it is more or less rigidly applied to the appointments in other branches of the administration. The age limit imposes practically no bar to the assumption of elective offices by retired government servants, and posts in the gift of the Crown are equally exempt from age restrictions. In all business concerns and industrial organizations, the directing authorities hold their offices virtually for life.

It is commonly argued that the age rule, though a purely arbitrary one, must be upheld in order to maintain in the services a uniformly high standard of efficiency which, it is feared, advancing age is apt to sterilize; and to secure for administrative problems that freshness and optimism of outlook which a comparatively youthful and more energetic mind may reasonably be supposed to possess. From an economic standpoint, the age rule scarcely appears to be a sound business proposition, and the consideration that the wastage due to retirement provides some measure of relief to unemployment seems to be its chief recommendation. Generally speaking it is true that the efficiency of a person depends not only on his protein metabolism but to a large extent also on the climatic conditions of the country in which he lives; and the influence of adverse environmental factors is likely to be more acute in the case of those who, born in more favourable situations, suddenly find themselves in different and more exacting circumstances, than in the case of races who through centuries have become perfectly inured to them. But this is not all. Of still more fundamental importance is the fact that the treatment accorded to the public servant has a direct influence on his official efficiency. It must be within the experience of all officials that if their career is not embittered by disappointments, and on the other hand, their hopes and ambitions are systematically and periodically fulfilled, their capacity for service is retained unimpaired till an advanced old age. The influence of mind on the discharge of duties is far more profound than is commonly recognized.

It is impossible to assume that the age of a person at fiftyfive in itself impairs his mind to the extent of disqualifying him for the performance of public functions. The constant vigilance and tireless energy so necessary for a successful business organization in which the directing authorities have to keep all their fingers on the pulse of the market, finance and labour, do not appear to be foreign to them though they may have crossed the official age limit. The official duties of the Prime Minister and of his colleagues in the Cabinet must be certainly of a very arduous character yet in their assumption, consideration of age plays little or no part. Really we are dealing with two classes of offices in public affairs where an anomalous position is created. Those which are in the gift of the government are regulated by age rules and others virtually in the gift of the electorate are independent of them, though in both the nature and volume of work to be transacted are almost the same, and if there is any difference at all the incidence is certainly heavier in the case of elective appointments. In the reformed constitution in India the ministerial posts are in the majority of cases occupied by retired government officers and others who, according to the fundamental rules, are not permitted to hold any office under government. Further it may be observed that in committees and commissions appointed by Government, officers who have relinquished their posts are also included in large numbers. It seems to us therefore that it is impossible to maintain that the service rules regulating the tenure of offices are based purely on considerations of the efficiency of their incumbents. In any case we have no standard scientifically determined for the measurement of such efficiency, and, this standard, if one is discovered, is unlikely to be suitable for uniform application to all persons in all branches of public administration; for the nature and intensity of the duties and the consequent wear and tear on the individual must differ widely between department and department and also in their effects on individual persons. Obviously, there can be little scientific justification either for fixing fiftyfive years as the general retiring age or for arbitrarily raising this to sixty years only in a few cases. It seems to us that in the interests of both economy and of efficiency, this rule is in need of immediate revision and in support of our view we may adduce the fact that most of the pensioned officers who seek engagements in quasi-public services or who apply for commutation of their pensions are declared to be sound in body and mind by the medical boards. The cost of pension for which the Indian Governments provide in their budgets is excessively heavy and fresh recruitment, on account of retirement under the existing rules, must materially add to the cost of administration.

We are concerned here more with the teaching profession than with any other. In missionary and other aided institutions, the fiftyfive-year rule is not as a matter of principle strictly followed, and in respect of certain endowed chairs in Indian universities their occupants are permitted to continue in office till sixty years of age. In Europe and America the practice varies. German professors, as is well known, are permitted to hold their appointments for life and are State servants. Similarly, the occupants of endowed chairs in English universities are not disturbed so long as they choose to continue to work and even secondary school teachers enjoy their tenure of office till their sixtieth year. Practically in all the progressive countries the European practice is adopted. The case is not materially different in institutions where engagements are entered into on the basis of short-term contract. In them the renewal of engagements has absolutely nothing to do with the age of the person, but is determined solely with reference to his efficiency. In India, however, the teaching posts in government service to whatever grade they may belong, generally terminate at the age of fiftyfive, the Government reserving to themselves the right of granting extensions sometimes even upto sixty years. There can be obviously no magic in the rule and the existing practice which is full of anomalies is capable of being based on some well-recognized psychological and physiological principle. One of the outstanding features of the great moral and material progress of India is the distinct improvement of the sanitary conditions of towns, where a generous supply of wholesome water, pure air, parks and playgrounds and other amenities which secure health and prolong life are available for all and consequently the outlook of life of an average citizen in Indian cities is favourably comparable with that of one in European towns living in similar conditions. What really depresses the soul of the teaching

profession is stagnation and utter lack of variety of work from which the other branches of service do not suffer. To some extent this may be compensated for by the daily contact of the professor with the bubbling enthusiasm of youthful minds, and by the exhilaration that comes from a joyous and unstinted devotion to original investigation that must tend to keep him young and hopeful. We are aware that the conditions of service in the different grades of the teaching profession differ radically and we shall deal here mainly with the members of a university staff.

The decision of the Government to terminate the services of professors at fifty-five years is one of those rules which in their very nature must operate unequally. It is perfectly true that some professors are too old at fifty or even forty, especially such as have neither a hobby nor vital interests beyond absolute routine; it is equally true that others are quite young at sixty-five or even seventy. It seems to us that in the higher branches of education, a living mind endowed with a wide and varied experience, a ripe and unfaltering judgment, a real enthusiasm and power to initiate and conduct research and a judicious temper and discernment must be a more valuable and indispensable asset than buoyance and vigour whether to universities or governments. Such a mind confers prestige and creates tradition. The two-fold nature of the work devolving on a professor demands at once a power and readiness on his part to put himself on a level with young and inexperienced men and a faculty to seek and establish variety in his own work. Age is commonly believed to produce in mind, a warped and embittered view of life, a total lack of sympathy with the overflow of youth, a dogmatic assertiveness "and an idealized memory of the greatness of past time". These effects, it must be remembered, are more pronounced in other walks of life than in teaching and so long as the professor maintains an inquisitive spirit towards learning and research, he is practically immune from the mental disease of old age. There are numerous cases of professors old according to government rules but young enough to retain their original freshness and mobility of mind to be able "to share in the enthusiasm of the young and to travel with them along the same road". The truth is that old age is not due to years but depends largely on circumstances and temperament "and the remedy therefore lies less in general rules than in the treatment accorded to the professor during his career." Compulsory retirement at fiftyfive years, we are convinced, is not a satisfactory remedial measure for a sickness which may have had its origin almost at the commencement of the service or even before. Subsequent conditions may either allay or aggravate the malady.

The first step is to prevent stagnation and routine from bearing unduly upon members of the university staff. For instance, the system of interchange of professors in the early stages of their career, study leave with deputation allowance in addition to usual emoluments and compulsory attendance at scientific and other conferences and congresses must help to keep the professor always alert and efficient. These suggestions may be supposed to be expensive and therefore may not commend themselves to the authorities, but the existing system of retiring the professors is equally exposed to this criticism. The scheme we here suggest has, however, the obvious advantage of securing for the institution concerned the foundations of prestige and tradition which cannot be measured in terms of money. At present Indian universities are labouring under a serious handicap in this respect though in spite of it some have already built up their own reputation, chiefly through the efforts of those who do not come under the fiftyfive-year rule. The absence of tradition is largely due to the operation of the fundamental rules which deprive our institutions of their professors precisely at the time when they are in a position to create it. The plan that we have put forward of releasing the professors for a definite period at regular intervals and of requiring them to spend these intervals in some way beneficial to the institution to which they belong, deserves immediate consideration.

In emphasizing the need and the urgency of revision of the fiftyfive-year rule, we are not asking for the establishment of a new procedure whose effects cannot be foretold. The system of making university posts life-time appointments has proved an advantage and an eminent success in Europe and other countries. In India the fiftyfive-year rule is not applicable to certain class of offices and there is practically no age limit except the disinclination of the person himself for elective offices and those connected with industries. We have no well-tested and absolute standards for measuring

the worth and efficiency of public servants and the vague apprehension that at fiftyfive an officer has ordinarily well-nigh exhausted his capacity for usefulness in public affairs will not stand close scrutiny. As we have pointed out that old age in the teaching profession is less due to advancing years than to circumstances and treatment, we should certainly have no hesitation in advocating the extension of the age limit to sixty years in the first instance, in the case of professors, and if the results are satisfactory, as we are confident that they will prove to be, occasion will not be wanting for a general and more comprehensive review of the rule in its bearing on other branches of educational service as well. The importance of research in our universities and of its power to create a tradition for the country is just beginning to be recognized by the public and the only tangible way of appreciating and encouraging it is to prolong the period of the usefulness of the professors in the universities upto at least sixty years.

Nuclear Structure.

By Prof. B. Venkatesachar, M.A., F.Inst.P., and T. S. Subbaraya, B.Sc.

THE isotopic constitution of a large number of elements is now known, while the study of band spectra and hyperfine-structure of line spectra has, in a considerable number of cases, led to the determination of nuclear spins with more or less certainty. There have been a number of attempts[1] to explain the isotopic constitution. The problem of explaining the observed nuclear spin has also been attacked: S. Bryden[2] and H. E. White[3] have attempted a solution on the hypothesis that nuclear spin is due to the spin and orbital motion of the protons while the electrons in the nucleus are supposed to have lost their spin. But, as Iwanenko[4] suggested and particularly as Heisenberg[5] has shown, it is unnecessary to postulate the separate existence of electrons in the nucleus; we may assume that the nucleus consists of protons and neutrons only. Now Heisenberg has deduced that the system of two protons and two neutrons, namely, an α-particle, is very stable. Hence we are led to postulate that pairs of protons and neutrons within the nucleus combine into as many α-particles as possible, an α-particle having, of course, no spin. When this is done the number of α-particles, protons and neutrons that compose a nucleus of atomic weight N and atomic number Z can be uniquely determined. The number of α-particles is the integral part of $Z/2$, and when Z is odd there is one proton. The number of neutrons is $N-2Z$ or $N-2Z+1$ according as Z is even or odd. To take an example, O_{17}, $Z=8$ contains 4 α-particles, no proton and 1 neutron, while Cl_{37}, $Z=17$ contains 8 α-particles, 1 proton and 4 neutrons. That Pauli's principle should apply to neutrons also has been pointed out by Heisenberg[6]. Considerations of the statistics of nitrogen nuclei have led him to postulate that every neutron has a spin of $\frac{1}{2}\, h/2\pi$. The occurrence of a large nuclear spin like 9/2 in the case of a few elements while in many other cases it is small, suggests that shells of neutrons which possess orbital motion must contribute to the nuclear spin. Accordingly, we have in this work assumed that the nucleus consists of $Z/2$ α-particles, and 1 proton when Z is odd, with $N-2Z$ or $N-2Z+1$ neutrons. The α-particles have no spin, and the contribution of the neutrons to the nuclear spin is the resultant of their spin and orbital moments while the resultant moment of the nucleus is equal to that of the neutrons together with that of the single proton if present. The resultant moment of the neutrons can then be calculated exactly as the resultant j-value in the case of extranuclear electrons. We may expect that the observed spin will be that corresponding to the j-value of the deepest term. Table I shows how far this procedure leads to the observed spins.

The above table shows that in the majority of cases the observed spin corresponds to the j-value of the deepest term. In the case of V, Mn, Cu, Ga, Cd, Sb, I, Cs, Ba_{137}, La, Pr and Pb the observed i-value (nuclear spin) does not correspond to the j-value of the theoretically deepest term, but to that of one of the other

[1] W. D. Harkins, *Phys. Rev.*, **38**, 1270, 1931.
H. C. Urey, *J. Am. Chem. Soc.*, **53**, 2872, 1931.
J. H. Bartlett, *Nature*, **130**, 165, 1932.

[2] S. D. Bryden, Jr., *Phys. Rev.*, **38**, 1989, 1931.

[3] H. E. White, *Phys. Rev.*, **38**, 2078, 1931.

[4] D. Iwanenko, *Nature*, **129**, 798, 1932.

[5] W. Heisenberg, *Zs. f. Phys.*, **77**, 1, 1932.

[6] W. Heisenberg, *Zs. f. Phys.*, **78**, 159, 1932.

TABLE I.

Nucleus	(Z) Atomic Number	No. of α-particles	No. of Protons	No. of Neutrons	Neutronic Configuration	j-values of deepest and some deep terms, l-s coupling	j-values of deepest and some deep terms, J-J coupling	Observed Spin	Calculated Spin including that of proton
H	1	—	1	—	—	—	—	$\frac{1}{2}$	$\frac{1}{2}$
He	2	1	—	—	—	—	—	0	0
Li_6	3	1	1	1	$1s^1$	$\frac{1}{2}$ $(^2S_{\frac{1}{2}})$	$\frac{1}{2}$	0	1 or 0
Li_7	3	1	1	2	$1s^2$	0 $(^1S_0)$	0	$\frac{3}{2}$	$\frac{1}{2}$
C_{12}	6	3	—	—	—	—	—	0	0
N_{14}	7	3	1	1	$1s^1$	$\frac{1}{2}$ $(^2S_{\frac{1}{2}})$	$\frac{1}{2}$	1	1 or 0
O_{16}	8	4	—	—	—	—	—	0	0
F	9	4	1	2	$1s^2$	0 $(^1S_0)$	0	$\frac{1}{2}$	$\frac{1}{2}$
Ne	10	5	—	—	—	—	—	0	0
Na	11	5	1	2	$1s^2$	0 $(^1S_0)$	0	$\geqslant \frac{1}{2}$	$\frac{1}{2}$
P	15	7	1	2	$1s^2$	0 $(^1S_0)$	0	$\frac{1}{2}$ or 1	$\frac{1}{2}$
Cl_{35}	17	8	1	2	$1s^2$	0 $(^1S_0)$	0	$\frac{5}{2}$	$\frac{1}{2}$
K_{39}	19	9	1	2	$1s^2$	0 $(^1S_0)$	0	$\frac{1}{2}$	$\frac{1}{2}$
Ca	20	10	—	—	—	—	—	0	0
V	23	11	1	6	$2p^2$	0, 1, 2 $(^3P_{0,1,2})$	0; 1, 2	$\geqslant \frac{5}{2}$	$\frac{1}{2}$, $\frac{3}{2}$ or $\frac{5}{2}$
Mn	25	12	1	6	$2p^2$	0, 1, 2 $(^3P_{0,1,2})$	0; 1, 2	$\frac{5}{2}$	$\frac{1}{2}$, $\frac{3}{2}$, or $\frac{5}{2}$
Fe	26	13	—	4	$2s^2$	0 $(^1S_0)$	0	0	0
Cu	29	14	1	6	$2p^2$	0, 1, 2 $(^3P_{0,1,2})$	0; 1, 2	$\frac{3}{2}$	$\frac{1}{2}$, $\frac{3}{2}$ or $\frac{5}{2}$
Ga	31	15	1	8	$2p^4$	2, 1, 0 $(^3P_{2,1,0})$	0, 2 : 1, 2	$\geqslant \frac{3}{2}$ ($\frac{1}{2}$?)	$\frac{5}{2}$, $\frac{3}{2}$ or $\frac{1}{2}$
As	33	16	1	10	$2p^6$	0 $(^1S_0)$	0	$\frac{3}{2}$	$\frac{1}{2}$
Br	35	17	1	10	$2p^6$	0 $(^1S_0)$	0	$\frac{3}{2}$	$\frac{1}{2}$
Rb	37	18	1	12	$3s^2$	0 $(^1S_0)$	0	$\geqslant \frac{1}{2}$	$\frac{1}{2}$
Sr	38	19	—	12	$3s^2$	0	0	0	0

Nucleus	(Z) Atomic Number	No. of α-particles	No. of protons	No. of Neutrons	Neutron Configuration	j-values of deepest and some deep terms, l-s coupling	j-values of deepest and some deep terms, J-J coupling	Observed Spin	Calculated Spin including that of proton
Cd_{111}	48	24	—	15	$3p^3$	$\frac{3}{2}, \frac{3}{2}, \frac{1}{2}$ ($^4S_{3/2}, {}^2P_{\frac{1}{2}, 3/2}$)	$\frac{3}{2}$; $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}$	$\frac{1}{2}$	$\frac{3}{2}, \frac{1}{2}$ or $\frac{5}{2}$
Cd_{113}	48	24	—	17	$3p^5$	$\frac{3}{2}, \frac{1}{2}$ ($^2P_{3/2, \frac{1}{2}}$)	$1\frac{1}{2}, \frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{2}$ or $\frac{1}{2}$
In	49	24	1	18	$3p^6$	0 ($^1S_0$)	0	$\frac{1}{2}$	$\frac{1}{2}$
Sb_{121}	51	25	1	20	$4s^2$	0 ($^1S_0$)	0	(?)	$\frac{1}{2}$
Sb_{123}	51	25	1	22	$3d^2 4s^2$	$^3F_{2, 3, 4}\, {}^3P_{0, 1, 2}$	0, 2 ; 1, 2, 3, 4	$\frac{3}{2}$	$\frac{5}{2}, \frac{1}{2}, \frac{3}{2}$ or $\frac{9}{2}$
I	53	26	1	22	$3d^2 4s^2$	2, 3, 4 ; 0, 1 ($^3F_{2, 3, 4}\, {}^3P_{0, 1, 2}$)	0, 2 ; 1, 2, 3, 4	$\frac{9}{2}$	$\frac{5}{2}, \frac{7}{2}$ or $\frac{9}{2}$ &c.
Cs	55	27	1	24	$3d^4 4s^2$	2, 3, 4 ; 0, 1, 2 ($^3F_{2, 3, 4}\, {}^3P_{0, 1, 2}$)	0 ; 1, 2, 3, 4	$\geqslant \frac{5}{2}$	$\frac{5}{2}, \frac{3}{2}, \frac{1}{2}, \frac{7}{2}$ or $\frac{9}{2}$
Ba_{135}	56	28	—	23	$3d^3 4s^2$	$\frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \frac{9}{2}$ ($^4F_{3/2, 5/2, 7/2, 9/2}$)	$\frac{3}{2}$; $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}$	$\frac{3}{2}$	$\frac{3}{2}$ &c.
Ba_{137}	56	28	—	25	$3d^5 4s^2$	$^6S_{5/2}, {}^4D_{\frac{1}{2}, 3/2, 5/2, 7/2}$	$\frac{5}{2}$; $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}$	$\frac{3}{2}$	$\frac{5}{2}$ or $\frac{1}{2}$ or $\frac{3}{2}$
La	57	28	1	26	$3d^6 4s^2$	$^5D_{4, 3, 2, 1, 0}$	0, 2, 4	$\frac{5}{2}$	$\frac{1}{2}, \frac{5}{2}$ or $\frac{9}{2}$
Pr	59	29	1	24	$3d^4 4s^2$	0,1,2,3,4 ($^5D_{0, 1, 2, 3, 4}$)	0, 2, 4	$\frac{5}{2}$	$\frac{1}{2}, \frac{5}{2}$ or $\frac{9}{2}$
Hg_{199}	80	40	—	39	$4d^1 5s^2$	$^2D_{3/2, 5/2}$	$\frac{3}{2}, \frac{5}{2}$	$\frac{1}{2}$	$\frac{3}{2}$ or $\frac{5}{2}$
Hg_{201}	80	40	—	41	$4d^3 5s^2$	$\frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \frac{9}{2}$	$\frac{3}{2}, \frac{1}{2}, \frac{3}{2}$	$\frac{3}{2}$	$\frac{3}{2}$ or $\frac{1}{2}$
Tl	81	40	1	42	$4d^4 5s^2$	2, 3, 4 ; 0, 1, 2	0, 2, 4	$\frac{1}{2}$	$\frac{1}{2}$ or $\frac{3}{2}$ &c.
Pb_{207}	82	41	—	43	$4d^5 5s^2$	$^6S_{5/2}, {}^4D_{\frac{1}{2}, 3/2, 5/2, 7/2}$	$\frac{5}{2}$; $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}$	$\frac{1}{2}$	$\frac{5}{2}$ or $\frac{1}{2}$ &c.
Bi	83	42	1	44	$4d^6 5s^2$	$^5D_{4, 3, 2, 1, 0}$	0, 2, 4	$\frac{9}{2}$	$\frac{9}{2}, \frac{1}{2}$ or $\frac{5}{2}$

deep terms. In the case of Li_7, Cl_{35}, As, Br, and Hg_{199} the spin does not follow from the configuration assumed, but if one neutron is supposed to be in a different orbit the observed spin may be accounted for. (1s 2s, 1s 2p, $2p^5 3s$, $2p^5 3s$ and $4d^2 5s^1$ would be the configurations in the case of Li_7, Cl_{35}, As, Br and Hg_{199} respectively). Such deviations from expectation are frequently met with in extranuclear configurations.

Further evidence in support of the structure assumed for the nuclei can be obtained from the known atomic weights of the lightest, heaviest and most abundant isotopes of the elements. In Table II the neutron configurations corresponding to these are given for all the elements for which data are available. This table shows that the most abundant isotope is in a majority of cases that which has a closed shell or sub-shell of neutrons. In those instances in which this is not the case, the neutron configuration of the most abundant isotope is seen to be one which may be expected to be very stable from the analogy of extra-nuclear electronic configurations.

TABLE II.

Atomic Number	Element	Lightest Isotope	Neutron Configuration of same	Heaviest Isotope	Neutron Configuration of same	Most abundant Isotope	Neutron Configuration of same	Element	Lightest Isotope	Neutron Configuration of same	Heaviest Isotope	Neutron Configuration of same	Most abundant Isotope	Neutron Configuration of same	Atomic Number
1	H	1	—	2	$1s^1$	1	—	Kr	78	$2p^2$	86	$3p^2$	84	$3s^2$	36
2	He					4	—	Rb	85	$3s^2$	87	$3p^2$	85	$3s^2$	37
3	Li	6	$1s^1$			7	$1s^2$	Sr	86	$2p^6$	88	$3s^2$	88	$3s^2$	38
4	Be					9	$1s^1$	Y					89	$3s^2$	39
5	B	10	$1s^1$			11	$1s^2$	Zr	90	$2p^6$	96	$3p^4$	90	$2p^6$	40
6	C	12	—	13	$1s^1$	12	—	Mo	92	$2p^4$	100	$3p^4$	98	$3p^2$	42
7	N	14	$1s^1$	15	$1s^2$	14	$1s^1$	Ru	96	$2p^4$	104	$3p^4$	102	$3p^2$	44
8	O	16	—	18	$1s^2$	16	—	Ag	107	$3p^2$	109	$3p^4$	107	$3p^2$	47
9	F					19	$1s^2$	Cd	110	$3p^2$	116	$4s^2$	114	$3p^6$	48
10	Ne	20	—	22	$1s^2$	20	—	In					115	$3p^6$	49
11	Na					23	$1s^2$	Sn	112	$3s^2$	124	$3d^4 4s^2$	120	$4s^2$	50
12	Mg	24	—	26	$1s^2$	24	—	Sb	121	$4s^2$	123	$3d^2 4s^2$	121	$4s^2$	51
13	Al					27	$1s^2$	Te	122	$3p^6$	130	$3d^6 4s^2$	130	$3d^6 4s^2$	52
								I					127	$3d^2 4s^2$	53
14	Si	28	—	30	$1s^2$	28	—	?X	124	$3p^4$	136	$3d^8 4s^2$	129	$3d^1 4s^2$	54
15	P					31	$1s^2$	Cs					133	$3d^4 4s^2$	55
16	S	32	—	34	$1s^2$	32	—	Ba	135	$3d^2 4s^2$	138	$3d^6 4s^2$	138	$3d^6 4s^2$	56
17	Cl	35	$1s^2$	37	$2s^2$	35	$1s^2$	La					139	$3d^0 4s^2$	57
18	A	36	—	40	$2s^2$	40	$2s^2$	Ce	140	$3d^4 4s^2$	142	$3d^6 4s^2$	140	$3d^4 4s^2$	58
19	K	39	$1s^2$	41	$2s^2$	39	$1s^2$	Pr					141	$3d^4 4s^2$	59
20	Ca	40	—	44	$2s^2$	40	—	Nd	142	$3d^2 4s^2$	146	$3d^6 4s^2$	142	$3d^2 4s^2$	60
21	Sc					45	$2s^2$	W	182	$4p^4$	186	$5s^2$	184	$4p^6$	74
22	Ti					48	$2s^2$	Re	185	$4p^6$	187	$5s^2$	187	$5s^2$	75
23	V					51	$2p^2$	Os	186	$4p^4$	192	$4d^2 5s^2$	192	$4d^2 5s^2$	76
24	Cr	50	$1s^2$	54	$2p^2$	52	$2s^2$	Hg	196	$4p^6$	204	$4d^6 5s^2$	202	$4d^4 5s^2$	80
25	Mn					55	$2p^2$	Tl	203	$4d^4 5s^2$	205	$4d^6 5s^2$	203	$4d^4 5s^2$	81
26	Fe	54	$1s^2$	56	$2s^2$	56	$2s^2$	Pb	206	$4d^4 5s^2$	208	$4d^6 5s^2$	208	$4d^6 5s^2$	82
27	Co					59	$2p^2$	Bi					209	$4d^6 5s^2$	83
28	Ni	58	$1s^2$	60	$2s^2$	58	$1s^2$	Po	210	$4d^4 5s^2$	218	$5p^2$	210	$4d^4 5s^2$	84
								Ra Em	219	$4d^9 5s^2$	222	$5p^2$	222	$5p^2$	86
29	Cu	63	$2p^2$	65	$2p^4$	63	$2p^2$	Ra	223	$4d^9 5s^2$	228	$5p^4$	226	$5p^2$	88
30	Zn	64	$2s^2$	70	$2p^6$	64	$2s^2$	Ac	227	$5p^2$	228	$5p^3$	227	$5p^2$	89
31	Ga	69	$2p^4$	71	$2p^6$	69	$2p^4$	Th	227	$4d^9 5s^2$	234	$5p^6$	232	$5p^4$	90
32	Ge	70	$2p^2$	77	$3s^1$	74	$2p^6$	Pa	231	$5p^2$	234	$5p^5$	231	$5p^2$	91
33	As					75	$2p^6$	U	234	$5p^2$	238	$5p^6$	238	$5p^6$	92
34	Se	74	$2p^2$	82	$3p^2$	80	$3s^2$								
35	Br	79	$2p^6$	81	$3s^2$	79	$2p^6$								

It will also be seen that similar neutron configurations give rise to the most abundant isotope irrespective of the total quantum number of the neutron shells. Thus $2p^2$, $3p^2$ and $5p^2$ occur equally often; so also $2p^4$ and $5p^4$ occur once. $3d^4 4s^2$ and $4d^4 5s^2$ occur the same number of times, while $3d^6 4s^2$ and $4d^6 5s^2$ also appear almost equally frequent. If we compare the relative abundance of the elements from Ca to Ni

we find that the elements having the electronic configurations d^2s^2, d^4s^2 and d^6s^2 are almost equally abundant but for the extraordinary abundance of Fe. So also the neutronic configurations d^2s^2, d^4s^2 and d^6s^2 equally often represent most abundant isotopes. All these regularities show that the tentative scheme here put forward represents one aspect of reality at least and leads us to hope that we may be on the right track. We have not tried to emphasize the regularities exhibited by the lightest and heaviest isotopes because we cannot here regard the present data as final. According to the scheme here put forward X_{129} cannot be expected to be the most abundant isotope of Xenon. X_{132} is nearly as abundant as X_{129} and has a stable configuration $(3d^4 4s^2)$. That there is some difficulty with regard to this element is also clear from the fact that the chemical atomic weight differs from that calculated from the relative abundance of the isotopes. In the case of light elements up to Oxygen, the configuration of 1 extra neutron and 1 proton seems to be stabler than that of 2 neutrons forming a closed s-shell. Thus although Li_7 is more abundant than Li_6, considerations of its spin show that its neutron configuration cannot be $1s^2$. In the case of Be, the one neutron cannot be very stable. Possibly this has something to do with the fact that the first discovery of the neutron was made by bombarding Be by α-rays. It is also very interesting to note that the regularity exhibited by the radio-active elements and their isotopes is similar to that shown by elements preceding them

The Concept of Causality.

THE above is the title of the Seventeenth Guthrie Lecture delivered by Prof. Max Planck before the London Physical Society on the 17th June. Recent advances in theoretical physics have impelled physicists to examine the concept of causality and its position in modern physics. In classical physics the existence of a causal relation was looked upon as a truism. Max Planck considers in his very interesting and thought-provoking address whether the position of the law of causality has been materially altered by quantum mechanics. The Professor starts by defining a causal link. "At the outset," he says, "we agree that in speaking of a causal link between two successive events we mean a certain connection, subject to law, between the two events of which the earlier event is called the cause, the later one the effect"; and again "an event is causally conditioned if it can be predicted with certainty". Starting from this definition he makes a careful examination of the concept in the light of recent advances in Physics and comes to the conclusion that "the world picture in quantum physics is governed by the same rigorous determinism which rules classical physics". One of the most interesting contributions to the enquiry is the way he tries to solve the problem by postulating an ideal mind. The reliability of any weather forecast depends on the knowledge of the meteorologist who predicts; the more knowledge he possesses o the atmospheric and other conditions o to-day the more reliable will be his predictions of to-morrow. Extrapolating, we may say that "an ideal mind, apprehending everywhere all the physical occurrences o to-day in their minutest points, should b able to predict with absolute accuracy th weather of to-morrow in all its details.' This may be extended to other physica events.

Finally, "the law of causality is neithe right nor wrong, it can be neither generall proved nor generally disproved. It i rather a heuristic principle, a sign-post (an to my mind the most valuable sign-post w possess) to guide us in the motley confusio of events and to show us the direction i which scientific research must advance i order to attain fruitful results. As the la of causality immediately seizes the awaken ing soul of the child and causes hi indefatigably to ask "Why?" so it accom panies the investigator through his whole lif and incessantly sets him new problem. For science does not mean contemplativ rest in possession of sure knowledge, means untiring work and steadily advancin development."

Importance of Dialysis in the Study of Colloids.

By Dr. B. N. Desai, M.Sc., Ph.D., B.A., LL.B.,
Wilson College, Bombay.

IN recent papers published from the Allahabad Laboratory; Dhar and collaborators[1] have studied some properties, *viz.*, viscosity and flocculation values with different electrolytes of colloidal solutions diluted and also dialysed to different extents. In their first paper Dhar and Gore have stated, "it appears also that research in colloid chemistry has not been systematic because each experimenter prepared the sol in his own particular manner, and the colloid contained different impurities and hence the stability and other properties are likely to vary from one specimen to another of the same sol prepared in different ways." From these papers one gets an impression that Dhar and collaborators were the first to find how the properties of a colloidal solution can be modified by varying its purity, *i.e.*, by subjecting it to dialysis. This impression is incorrect in that Desai[2] drew for the first time attention to the fact that a colloid can be made to show either normal or abnormal behaviour to the dilution rule when it is coagulated by electrolytes containing monovalent coagulating ion by subjecting the colloid to dialysis for different periods, and that it is erroneous to classify colloids into two divisions according to their behaviour towards the dilution rule as done by Dhar and collaborators. Since then papers have been published by Desai and collaborators[3] in which it has been shown how the properties, *viz.*, (1) stability (as determined by coagulating concentration) towards electrolytes and non-electrolytes, (2) behaviour towards the dilution rule, (3) behaviour towards the Schulze-Hardy Law, (4) auto-catalytic nature of the coagulation process, (5) relation between charge (as deduced from cataphoretic speed measurements on the assumption that the rate of migration represents density of the charge) and stability, and (6) relation between charge and viscosity of a colloidal solution can be made to vary by subjecting it to dialysis for different periods.

In a previous note[4] it was stated "the electro-viscous effect will produce a continuous *decrease* in the viscosity during the period when the charge on colloid increases with the progress of dialysis." It should have been "the electro-viscous effect will produce a continuous *increase* in the viscosity....when the charge on the colloid increases....dialysis." The concentration of the colloid did not change appreciably during dialysis and hence viscosity will not change as a result of it. Of the various factors discussed there, *viz.*, (1) electro-viscous effect, (2) hydration, (3) structure of the particles, and (4) electrolyte content, factors (1), (2) and (3) will increase viscosity in the initial stages of dialysis of thorium hydroxide (*i.e.*, till the maximum value of the charge is reached), factor (1) being most important; on the other hand, during the later stages of dialysis (*i.e.*, when the charge begins to decrease after the maximum value is reached) the increase in viscosity might be due to factors (2) and (3), the former having a marked effect and the influence of factor (1) on viscosity being not allowed to be noticed at all. Therefore, one can conclude that neither the view of v. Smoluchowski[5] nor of Dhar[6] can individually explain the changes in charge and viscosity with the progress of dialysis in the case of colloidal thorium hydroxide.

From our measurements of the cataphoretic speed with the progress of dialysis of colloidal solutions of gold, ferric hydroxide and thorium hydroxide we have found that in all the cases the charge on the colloidal particles first increases and then decreases (concentration of the colloid did not change appreciably during dialysis). We have observed that generally the cataphoretic speed first increases and reaches a maximum value on the addition of small amounts of an electrolyte with univalent coagulating ion, and then decreases on the addition of further larger amounts of the electrolyte (unpublished results). The initial increase in the cataphoretic speed is due to "preferential" adsorption of the similarly charged ion, the word "preferential" being used to indicate that the ion goes to the inner side—nearest to the particle of the double layer. (In the case of sols containing only traces of the peptising agent—highly purified sols—the initial increase in the cataphoretic speed in the presence of small amounts of an electrolyte is not well pronounced.) The process of dialysis can be taken without any serious objections as the reverse of the above process because the amount of the peptising agent initially present in the sols is appreciably more than what will correspond to the maximum in the cataphoretic speed—concentration curve of the colloid with the peptising agent, and therefore the charge on the colloid will first increase and then decrease with the progress of dialysis (*cf.* Freundlich, *Colloid and Capillary Chemistry*, 1926, English Translation, p. 506). The decrease in charge in the later stages of dialysis is due to removal of stabilising agent from the double layer. Therefore if a colloidal solution

[1] Dhar and Gore, *J. Indian Chem. Soc.*, **6**, 31, 641, 1929 and Mitra and Dhar, *ibid.*, **9**, 315, 1932.

[2] *Kolloidchem. Beihefte*, **26**, 384, 1928.

[3] Patel and Desai. *Trans. Faraday Soc.*, **26**, 128, 1930; *Kolloid-Zeit.*, **51**, 318, 1930; Nabar and Desai, *Nature*, **127**, 666, 1931; Desai and Barve, *ibid.*, **128**, 907, 1931; Desai, *Current Science*, **1**, 37, 1932; paper by Desai, Nabar and Barve on "Relation between charge and stability of colloidal solutions of gold and ferric hydroxide dialysed to different extents" (in course of publication) and paper by Desai on "A note on the existence of critical potential characteristic of coagulation of a colloid by an electrolyte" (in course of publication).

[4] Desai, *Current Science*, **1**, 38, 1932.

[5] *Kolloid-Zeit.*, **18**, 194, 1916; also see Kruyt and his co-workers, *Kolloidchem. Beihefte*, **28**, 1, 1929 and **29**, 413, 1929.

[6] Mitra and Dhar, *loc. cit.*

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initially contains an amount of an electrolyte which is greater than what will correspond to the maximum in the cataphoretic speed-concentration curve of that colloid with the particular electrolyte, the charge on the colloid when it is subjected to dialysis will first increase and then decrease. On the other hand, if the amount of the electrolyte initially present is equal to or less than what will correspond to the maximum in the cataphoretic speed-concentration curve, the charge on the colloid will continuously decrease with the progress of dialysis.

The changes which will be produced in the charge on the particles of a colloidal solution with the progress of dialysis are not so simple as many colloid chemists seem to imagine. It is clear that results of viscosity and stability as determined by the coagulating concentration of an electrolyte cannot always be utilized for getting an idea about the charge on the colloidal particles, for whether there is any relationship between charge and viscosity and charge and stability will depend upon the amou of the stabilising agent initially present in tl sol besides other factors like hydration, etc. Und the circumstances it is difficult to understa how far one should consider as satisfactory tl interpretations of the results of coagulation colloids by electrolytes whenever inferences ha been drawn from those results about charge ‹ the colloidal particles ; also one cannot get an id of the extent to which preferential adsorption either the stabilising or of the coagulating ion tak place from viscosity and flocculation val determinations. It is, therefore, necessary th simultaneous measurements of charge, viscosit flocculation value, etc., of every colloidal soluti containing varying amounts of the peptisi agent (this can be done by subjecting the colloi solution to dialysis for different periods) shou be made in order to get a clear idea about t relationship between charge and other properti In our Laboratory we are investigating vari colloidal solutions from these points of view

Present Position of the Problem of Spike Disease.*

By M. Sreenivasaya.

TWO schools of thought have influenced the study of Spike Disease both in the field and in the laboratory, since its discovery by McCarthy in the year 1899. Exponents of the physiological school believed that the characteristic symptoms induced in sandal are due to the imposition of an unfavourable environment, brought about by drought, fire, deprival or death of host plants, unbalanced sap circulation, unfavourable host plants and other purely physiological causes. In 1917, Dr. Coleman lent brilliant experimental support to the "infectious theory" of spike disease by the experimental disease transmissions he was able to effect by cleft grafting, the scion for the operation being derived from a diseased plant. This achievement marks a definite stage in the history of spike investigation.

Cleft grafting is a difficult technique; the percentage of success is small, even in the hands of the expert: the operation involved the cutting back of the stock and this gave the plant "a severe physiological shock," in the words of the exponents of the physiological theory, who tried to explain away the most important and definite result achieved by Dr. Coleman.

It is true that his experiments were conducted on stocks growing under natural conditions; it is also true that the host plants nourishing the operated stocks w not determined. Other methods of tra mission by budding and sap injection] failed. It was at this stage, that the prob was taken up by the Indian Institute Science in the year 1927, the Governmen Madras and the Commission of Coorg hav generously agreed to finance the sch proposed by Dr. Norris.

Culture of sandal plants in pots in sociation with known species of hosts m ed the next important stage in the prog of Spike Disease investigation. This achi ment simple as it appears at the mom helped to remove the reproach inheren experiments conducted under un-control natural conditions where many unknown non-determinable factors operate. All periments conducted at the Institute h been done with pot cultured sandal pla whose nourishing host, age and phy logical condition are all definitely known

The development and perfection of easy and an effectively reproducible artif disease transmission is an important indispensable to the progress of the inves tion; new methods of disease transmis extremely simple and elegant involvin "physiological shock" to the operated st have now been evolved; the weight o infective material has been reduced to a milligrams of diseased tissue. This me which has lent itself to quantitative co has been of immense value in evaluatin relative resistance or comparative susc

* Abstract of a lecture delivered at Coimbatore, under the auspices of the Society of Biological Chemists, India, on 8th October 1932.

bility of individual sandal plants growing under different conditions of environment; the technique has also been employed in determining the resistance offered by a composite environment to artificial infection.

The simplest and the readiest way of diagnosing spike is through the external symptoms; but the method often fails even in the case of the experienced observer. This is how the exponents of the physiological theory have been misled and have mistaken these symptoms generally produced through drought, fire, etc., as those of genuine spike. Symptoms produced through physiological causes are not communicable to other healthy plants through grafting while those of genuine spike are readily transmissible. Communicability of the symptom from one plant to another is the criterion on which infectious nature of spike disease has been firmly established.

Relative immunity can be imparted to the sandal plants by nourishing them with certain types of host plants, generally non-leguminous. *Pongamia glabra*, *Cajanus indicus* and *Acacias*, generally those which favour a rapid growth of the parasite, render it particularly susceptible to disease. The observation is borne out not only by ecological survey of the diseased and healthy areas, but also in the regeneration plots where only those associated with leguminous hosts have succumbed to the disease.

Mr. Dover of the Forest Research Institute, Dehra Dun, supplemented the lecture with an account of the entomological work which is at present mainly directed to prove whether insects are vectors or not.

Letters to the Editor.

Nomenclature of Shell Layers.

MAY I crave the courtesy of the columns of the *Current Science* to reply to a criticism of the terminology for the various shell-layers as used in my recent Memoir on *Pila* in the *Indian Zoological Memoirs'* series, by Dr. C. Amirthalingam in his note entitled "Correlation of Sex and Shell Structure in a Mollusc—*Trochus niloticus* Linn," published in your September issue? In his first footnote Dr. Amirthalingam remarks, "The terms used here are those generally accepted by English-speaking authors; those used in a Memoir on *Pila* (*The Indian Zoological Memoirs*) differ from this terminology." Leaving out of consideration the use of the structural names, nacreous and prismatic layers, the main differences in the terms employed by Dr. Amirthalingam and myself are in reference to the use of the terms Ostracum and Hypostracum. On a reference to the literature it will be seen that the terms ostracum and hypostracum were introduced into literature by Thiele[1] in 1892. The term hypostracum was used by Thiele in a loose sense for the innermost layer of the shell. In shells of *Chiton* he designated the entire innermost layer as the hypostracum, but in the account of *Patella* he restricted this name to the shell-layer in the region of attachment of the columellar muscle. Later in the same paper when describing the shell of *Gibbula magus*,—a Trachid,—he designated the innermost shell-layers of the upper whorls of the shell, which are in no way connected with the columellar muscle, as the hypostracum. This confusion in the use of the term hypostracum was pointed out by Simroth[2] who concluded "Es ist whol klar, dass man diese locale, unbedeutende Schicht kaum mit Thiele (s.o.) als Hypostracum deuten kann. Wenn man den Ausdruck festhalten will, dann kann bloss die Perlmutterschicht, soweit sie von der ganzen Mantelfläche abgeschieden wird, bezw. die innere vierte Schicht von *Buccinum* als Hypostracum gelten." The usage of the term hypostracum in the original confused sense of Thiele is followed in an English text-book by Pelseneer,[3] the famous Belgian malacologist and not an "English-speaking" worker, while I have used it in the modified sense of Simroth, as has been done by other workers like Robert[4] in Trochidæ and Bergenhayn[5] for Mollusca in general.

I have also to enter here a protest against the introduction of the new term—gonidial twist—which is apparently meant to replace

[1] Thiele, J., *Zeitschr. wiss. Zool.*, **55**, 220, 1892.

[2] Simroth, H., *Gastropoda-prosobranchia in Bronn's Tierreichs-Mollusca*, **3** (2), 232, 1899.

[3] Pelseneer, P., *Lankester's Treatise of Zoology*, Pt. V, *Mollusca*, p. 4, 1906.

[4] Robert, A., *Zool. Descriptive*, II, p. 382, 1900.

[5] Bergenhayn, J. R. M., *Kungl. Svensk.-Akad. Handl.*, (3) **9**, No. 3, p. 1, 1930.

the generally accepted term Visceral mass (of English authors), Sac visceral (of French) or Eingeweidesack (of German workers). In *Trochus*, as in Gastropods in general, the hermaphrodite gland, the ovary or the testis, as the case may be, is attached mainly on the upper surface of the upper whorls of the twisted visceral mass in the apical part of the digestive gland or the liver, and the designation of the apical whorls of the visceral mass as the gonidial twist cannot possibly be accepted as correct.

BAINI PRASAD.
Indian Museum, Calcutta,
October 1, 1932.

Indian Blepharoceridæ (*Insecta: Diptera*).

IN concluding his third note on the Indian Blepharoceridæ, Dr. A. L. Tonnoir[1] has pointed out that "no further important progress in the knowledge of the Blepharocerid fauna of India can be made unless collectors concentrate more on obtaining the adult stages rather than the early ones." A study of the larvæ and pupæ, though inadequate for toxonomic purposes, has already revealed that in India the Blepharocerid fauna is "the richest of the world in the number of genera". With a view to interest collectors in these remarkable insects a short account was published[2] of their habits and habitats based upon a series of observations made in the field in different parts of India. Reference was then made to the paucity of the adult material and to the inadequate knowledge of the methods of collecting the flies. In reply to an inquiry Dr. Tonnoir has informed me that sometimes sweeping the vegetation with a net in the vicinity of breeding places yields good results, especially with *Apistomyia*. The males of this genus, however, dance in small swarms high up above waterfalls. The females of many species can be obtained while egg-laying on the rocks right at the water's edge. Sometimes these elusive insects shelter under overhanging rocks or large boulders in the rapids. They have also been observed to flutter slowly just above the surface of the water in the spray of the falls, where it is very difficult to detect them. Dr. Tonnoir has observed that the abundance of the larvæ and pupæ in a particular place does not necessarily denote the presence of a large number of adult insects, and *vice versa*. He found a species of *Edwardsina* clustering in thick masses under overhanging rocks; the flies used to leave this shelter in the afternoon and fly up and down the rapids in millions. During the course of my work on the torrential populations of India I have looked for the flies in the "niches" referred to above, but have found instead a large variety of Empid and the Tipulid flies; probably I have not been fortunate enough to be in the field at the season of eclosion of the Blepharocerid flies.

This note is written with a view to stimulate interest in the collection of the adult stages of the Blepharoceridæ. If pupæ can be removed without injury to the animals, they can be induced to eclose by keeping them on wet cotton in a tube. They should, however, never be submerged under water. It is, however, difficult to breed these insects without adequately reproducing torrential conditions, for their larvæ live on bare and smooth rocks in the fiercest currents.

SUNDER LAL HORA.
Zoological Survey of India,
Indian Museum, Calcutta,
October 4, 1932.

[1] *Rec. Ind. Mus.*, **34**, 275, 1932.

[2] *Jour. Bombay Nat. Hist. Soc.*, **35**, 342, 1931.

Life of the Liquid Drops on the Same Liquid Surface.

IN continuation of his previous papers* on the subject, the author has now studied different methods to prolong the life of the

*1. J. B. Seth, C. Anand and L. D. Mahajan "Liquid Drops on the Same Liquid Surface," *Phil. Mag.*, **7**, 247, 1929.
2. L. D. Mahajan, "The Effect of the Surrounding Medium on the Life of Liquid Drops," *Phil Mag.*, **10**, 383, 1930.
3. L. D. Mahajan, "Liquid Drops on the Same Liquid Surface," *Nature*, **126**, 761, 1930.
4. L. D. Mahajan, "Liquid Drops on the Same Liquid Surface," *Nature*, **127**, 70, 1931.
5. L. D. Mahajan, "Size of the Liquid Drops on the Same Liquid Surface," *Phil. Mag.* (in press).
6. L. D. Mahajan, "Size of the Liquid Drops on the Same Liquid Surface," *Current Science*, **1** 100, 1932.
7. L. D. Mahajan, "Effect of Low Pressure on the Life of Liquid Drops," *Phil. Mag.* (in press).
8. L. D. Mahajan, "Effect of Low Pressure on the Life of Liquid Drops," *Nature* (in press).
9. L. D. Mahajan, "Effect of Disturbing Factors and Temperature on Liquid Drops," *Zeitschrift fur Physik* (in press).
10. L. D. Mahajan, "Theories of Liquid Drops on the Same Liquid Surface," *Physical Review* (in press).

liquid drops on the same liquid surface and has found that the following factors help in prolonging their life:—

Vibration of the liquid surface:—It prolongs the life of the liquid drops on the same liquid surface. The greater the vibrating motion of the liquid surface, the longer is the life of the drops.

Motion of the liquid surface:—It also increases the life of the drops. The greater is the rectilinear velocity of the liquid surface, the longer the floating drops live.

Movement of liquid drops themselves on the calm and motionless surface of the liquid:—This also prolongs their life. This is why the secondary drops have longer life than the primary ones.

Addition of more viscous substance to the mother liquid:—It helps upto a certain limit, but if the viscous substance is added beyond that limit, the formation of such drops becomes impossible.

Viscosity of the surrounding medium:—As it increases, the life of such drops also increases. It has a simple and rectilinear relation with the life of the drop.

Absence of impurities in the surrounding medium:—The presence of impurities in the surrounding medium makes the drops very unstable, while absence of them makes them very stable.

Saturated vapours of the mother liquid:—If saturated vapours of the mother liquid are present in the surroundings the drops become very stable.

Surface viscosity of the mother liquid:—It also affects the floating drops to some extent.

The details of the above conclusions, experiments and examples will be published soon.

L. D. MAHAJAN.

Physics Laboratory,
Mohindra College, Patiala, India,
September 3, 1932.

The Alimentary Glands of the Earthworms of the Genus *Eutyphœus*.

THE glands associated with the alimentary canal of *Eutyphœus* fall under three categories according to their position along the alimentary canal: (*a*) Pharyngeal glands, (*b*) Calciferous glands in the region of the œsophagus, and (*c*) the Alimentary glands[1,2] in the region of the intestine. The glands of the first two groups have been thoroughly investigated on different occasions by several workers, the latest work being that of Stephenson,[3,4] but the alimentary glands have not received any attention so far. I, therefore, determined to investigate the morphology of these structures in the two species of *Eutyphœus* that occur in Lucknow and read a preliminary note before the Zoology Section of the Indian Science Congress in 1923.[5] The chief features of these glands are as follows:—

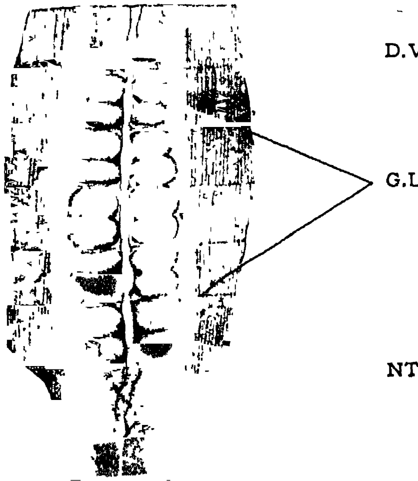

Fig. 1.
Glands as seen in dissection.

The glands are paired structures, fairly conspicuous in the ordinary dissection of the animal, extending over the intestine on either side of the dorsal vessel in four to five consecutive segments, beginning with the segment LXXX backwards. They are separated from each other by the intervening septa and are bilobed, as shown in Fig. 1. These glands are in communication with the alimentary canal by independent openings that are lined by ciliated epithelium, as shown in Fig. 3.

The histology of the glands shows that each is composed of a large number of lamellæ projecting into the cavity of the gland, and these either unite with the adjacent lamellæ or split to reunite (Figs. 2 and 4). Some of the lamellæ are larger than the rest and all of them contain blood spaces,

[1] *Rec. Ind. Mus.*, Calcutta, **10**, 1914.
[2] *Oligochæta* (Oxford Univ. Press), 1930.
[3] *Quart. Jour. Microsc. Sci.*, **62**, 1917.
[4] *Trans. Roy. Soc. Edin.*, **52**, 1919.
[5] *Proc. Tenth Ind. Sci. Cong.*, Lucknow, 1923.

some of which swell up at their free ends owing to the engorgement of the blood.

Fig. 2.
Microphotograph of the glands in section.

The glands have peritoneal cells covering the muscular layer, which latter is, however, deficient in the lamellæ. The inner lining of the gland consists of cubical cells full of granular material, which also surround the lamellæ (Fig. 4).

Fig. 3.
Glands near the opening into the intestine showing ciliation.

Fig. 4.
A few lamellæ of the gland showing disposition of cellular structure.

The blood supply of the glands is from the dorsal vessel and also from the subneural vessel. The branches of both the vessels ramify in the substance of the gland and form a complete anastomosis, thereby indicating a kind of portal system. Further investigations may show that the glands are of the nature of a liver that pours a digestive secretion into the gut.

G. S. THAPAR.

Department of Zoology,
University of Lucknow,
September 28, 1932.

Maintenance of Oscillations by a Triode with Filament Feed Cut Off.

WHEN some types of dull emitter tubes, *e.g.*, Cossor 215 P, Cossor 220 P, and Cossor 210 H.F., are made to generate oscillations in the normal way by coupling the grid coil inductively to the oscillatory anode coil, it is found that the oscillations continue to be maintained even when the filament battery is entirely disconnected. The mean anode current, however, as also the oscillatory current, drops to 50 to 80% of the original value and there is a slight reduction in the filament temperature as can be judged by the comparatively fainter glow of the filament. On applying the grid voltage fluctuations to one pair of the deflecting plates of a low voltage Cathode-Ray Oscil lograph, it was found that the negative gric swing exceeded 30 volts. The observed filament glow and the electron emission resulting therefrom appear, therefore, to be maintained by the bombardment of the electrons repelled from the grid towards the filament during that major portion of th cycle when the grid is negative with respec to the filament. A series of characteristic curves was drawn for the tubes that show this behaviour, and a careful study of thes curves does not reveal the presence o detectable traces of any gas indicating there by that the filament is bombarded mainly i not exclusively by electrons.

I have not been able to find mentio made of this effect anywhere. A mor detailed account of the phenomenon will b shortly published elsewhere.

R. L. NARASIMHAIYA.

Department of Physics,
Central College, Bangalore,
October 12, 1932.

A Siluroid Fish from Afghanistan.

Glyptosternum reticulatum McClelland.

Glyptosternum reticulatum was briefly an inadequately described by McClelland i 1842[1] from Sir-i-Chusma, the source of tl Kabul River, and since then it has cause considerable confusion in the toxonomy of certain Sisorid fishes. In the August issu of the *Annals and Magazine of Natur History* evidence was adduced to show th *G. reticulatum* is identical with the wel known and widely distributed speci "*Parexostoma stoliczkæ* (Day)" and th

[1] *Calcutta Journ. Nat. Hist.*, 2, 584.

Parexostoma Regan is a synonym of *Glyptosternum* McClelland. These conclusions were based on an examination of abundant material collected by my colleague Dr. B. N. Chopra in the Chitral Valley, from which waters drain into the Kabul River.

Through the courtesy of the Bombay Natural History Society I have received a small collection of fish, comprising 4 specimens, made during August last in the Paghman River, a tributary of the Kabul River, by the Legation Surgeon to the British Legation at Kabul. In this lot there is a well-preserved specimen of *G. reticulatum*, the study of which leaves no doubt whatsoever of the identity of McClelland's much-discussed species with *P. stoliczkæ*, and in consequence changes will have to be made in the nomenclature of these, as well as in the closely allied Sisorid fishes.

SUNDER LAL HORA.
Zoological Survey of India,
Indian Museum, Calcutta,
October 22, 1932.

Gregarious Collembola.

TURK[1] describes the swarming of Collembola in England and Davies[2] indicates the cannibalistic habit observed by him as a factor of swarming. There is no record of these interesting phenomena from India. Since swarming is confined to gregarious species only (Turk)[1], I give below a few examples of gregarious Collembola of Calcutta.

Protanura Carpenteri M,[3] which has been reported by me to be gregarious in habit is found occasionally congregated in large numbers among kitchen garbage in Calcutta. *Onychiurus fimetarious* L, recorded by Handschin[4] from South India, has been observed by me to live in colonies in the crevices of a wall close to a water reservoir. Both immature and mature individuals banded themselves at dusk into groups over the floor adjoining the wall. Swarming took place at the end of last July and specimens formed such a dense mass as to cover nearly the whole of the lower portion of a damp wall of a kitchen. The increase in number was such that specimens for days together were found carried away with the drainage water. The third example of gregarious habit is furnished by a species of *Lepidocyrtus* specimens of which were seen crowded together near the surface of water and a number of their moulted skins occurred matted together.

I have not seen in any of these cases the cannibalistic habit reported for the first time by Davies.[2] Humidity is undoubtedly necessary for the existence of these atracheate species; but I believe, they would not, if the humid condition were favourable and uniform all over the locality, collect themselves into groups, unless there were other factors at work. Although the actual food of the gregarious collembola could not be determined by direct observation,[3] an abundant supply of food as suggested by Turk[1] seems to be the important factor for keeping the members together. The cannibalistic habit referred to, may be explained in a different way as supplementing supply of food at times of scarcity rather than as a factor of swarming.

In discussing factors of swarming of these apterous insects, it should, however, be mentioned whether the term swarming is used in the same sense as in truly social insects as otherwise a confusion may arise between a temporary congregation and swarming that implies an active productive phase and migration for founding new colonies.

DURGADAS MUKERJI.
Zoological Laboratory,
University College of Science,
Calcutta.

1 *Nature*, **129**, 830, 1932.
2 *Nature*, **130**, 94, 1932.
3 *Rec. Ind. Mus.*, **34**, 49, 1932.
4 *Rev. Suiss. Zool.*, **36**, 236, 1929.

Some Studies in the Infra-Red.

IN continuation with the work on the absorption spectra a self-recording spectrometer is constructed in order to avoid the uncertainties of visual observations which are found to be long and laborious. Since the time of Langley many designs have been suggested, especially by French workers in this field. In the construction of this instrument special precautions have been taken to protect it from stray radiations and to keep the rock-salt prism unaffected by moisture. A definite advance has been made in the technique of the instrument with the result that the fine line structure of the infra-red absorption bands has been observed with considerable precision. This has been secured by modifying the older methods, increasing the resolving power of the dispersing apparatus and enhancing the

sensitivity and the control of the recording instrument.

The spectrometer consisted of two 30° prisms A and B of rocksalt. The one was fixed and the other could be rotated round a vertical axis and was mounted on the table LMNO. These two prisms were arranged in such a way that they acted as one at the position of the minimum deviation. To the table were also attached a concave mirror M_2 and a Hilger Thermo-electric Pile P. The radiations from a constant source (a Nernst Lamp) were made parallel by another concave mirror M_1 and after traversing the two prisms were concentrated by the mirror M_3 on the thermopile.

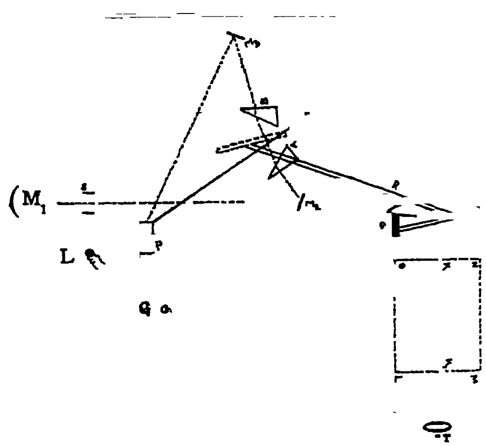

Fig. 1.

Self-Recording Spectrometer.

The recording instrument used was a Paschen Galvanometer with all the devices for protecting it from the external vibrations. Later on it was found that a Moll type galvanometer could conveniently be replaced with all the possible advantages. It was extraordinarily little disturbed by vibrations or external magnetic fields and its sensitivity was also found to be much higher than that of Broca type and about one-sixth of that of Paschen.

As in many self-recording instruments, the spot of light from the galvanometer traced a curve corresponding to the wave-length on an emulsion sensitive paper wrapped round a drum kept rotating by means of a small motor at a constant speed. The drum was also connected to the axle of the prism table by means of a lever arrangement RG. A 60° prism was found unsuitable for this work as a rotation of about 10° could turn all the rays out of the field.

The one conspicuous feature of the instrument was that it could obtain automatically and without the possibility of any personal error a photographic record of the absorption spectra in an appreciably short time.

The instrument before use was calibrated by means of some definite and known radiations. For this purpose the emission bands of CO_2 given by the Bunsen flame at $4 \cdot 32\mu$ and $4 \cdot 43\mu$ and those of other substances were used.

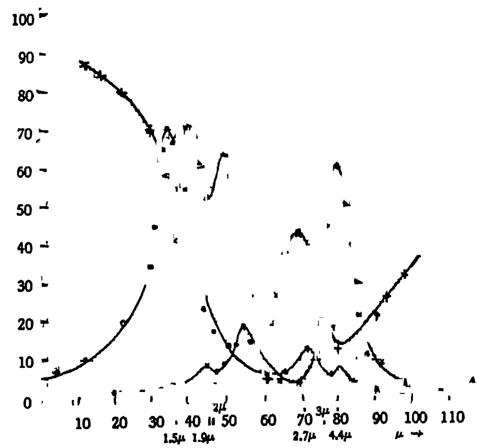

Fig. 2.

Calibration Curve.

× ×—Absorption Curve for Gypse.

▪ ▪ Emission Curve for Gas (CO_2).

Two of the transmission curves of benzene and nitro-benzene are given in Figs. 3 and 4. Continuous and the dotted lines indi-

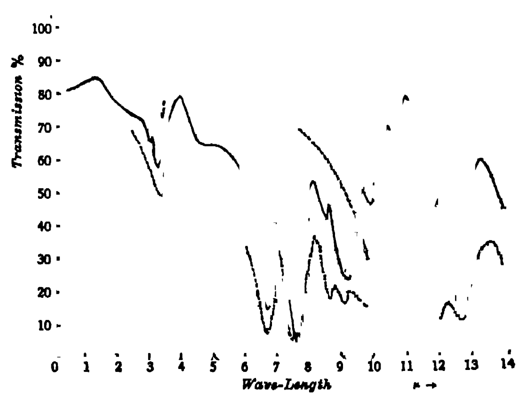

Fig. 3.

Benzene—C_6H_6.

$t = 0 \cdot 01, \cdot 02$ mm.

cate the different thicknesses of the cells used, which were 0·01 mm. and 0·02 mm. in the case of benzene and 0·014 and 0·02 mm. for

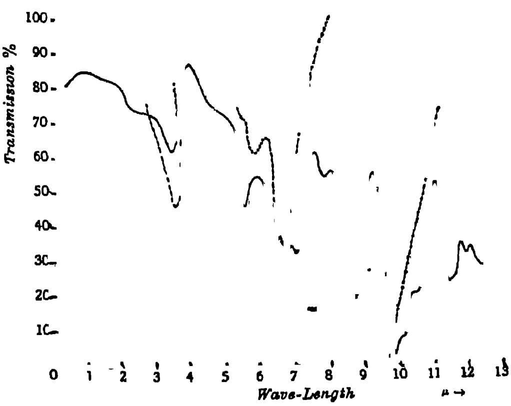

Fig. 4.

Nitro-Benzene—$C_6H_5NO_2$.
t=0; ·015 mm.

nitro-benzene. (They were calculated afterwards by direct measurements.)

The benzene spectrum showed a great transparency throughout the whole spectrum upto $14 \cdot 2\mu$ when it became suddenly opaque. The bands at $3 \cdot 25\mu$ and $6 \cdot 8\mu$ are to be noted very carefully as they occur in all the complex derivatives of benzene, and lead to the conclusion that the vibration of the benzene molecules is not destroyed.

The spectrum of nitro-benzene on the whole showed numerous and well-defined absorption bands. From the comparison of the curves for benzene and nitro-benzene it appears that the introduction of NO_2 group does not very much affect the benzene spectrum. Besides, there does not appear to be any other characteristic vibration due to this group, but there is a likelihood of $1 \cdot 15\mu$ band to be associated with it as this band is often found in all the spectra of the compounds having NO_2 group.

The other characteristic bands found from the curve were at $3 \cdot 3\mu$, $6 \cdot 25\mu$, $8 \cdot 6\mu$, $9 \cdot 85\mu$, and $11 \cdot 4\mu$.

A. P. MATHUR.

Bombay,
October 24, 1932.

Thermo-Hardening of Shellac.

SHELLAC and the Australian Acaroids, alone amongst the natural resins possess the property of thermo-hardening. This property is similar to the 'going-over' under heat exhibited by the phenol-formaldehyde class of synthetic resins, the commercial possibilities of which have been so energetically and successfully developed. The possibility of developing this property of shellac on similar lines has been investigated in this laboratory.

As a preliminary, a study was made of the factors influencing the time of heating required to 'cure' shellac. The possibility of considerably retarding or accelerating the process by additions of small quantities of certain materials has been established. These materials can apparently be classified into certain groups; *e.g.*, retarding substances include alkalis and solvents, while accelerators include acids, ester-forming catalysts, ammonia and ammonium liberating agents.

The effect of pressure was shown to be of great importance as it produces a very big retarding influence. This is a serious obstacle to the use of shellac as a moulding binder as the time of curing *in the press* is extremely long. It was found necessary to cool the mould before removal from the press and subsequently complete the cure at a low temperature, *i.e.*, about 80—90°C. Moulding prepared by this method, with addition of certain accelerators, have been shown to possess improved heat-resistant properties.

It is hoped that a paper will shortly be published describing the above work.

R. W. ALDIS.
S. RANGANATHAN.

Indian Lac Research Institute.
Namkum, Ranchi,
October 20, 1932.

Coronium Spectrum.

THE identification of the Coronium Spectrum with the spectrum of oxygen by T. L. de Bruin has evoked considerable interest recently in astrophysical circles, and in spite of the strong combinations which he has observed in the new terms of the oxygen spectrum, explaining some of the most important line of Corona, it must be admitted that the criticism of some of the very careful workers in the field of spectroscopy cannot be easily met. Theoretically there is no place for the new terms discovered by de Bruin. And with our past experience with the modern theory of spectra it is hard to believe that our present-day methods for calculating the spectroscopic terms are not materially correct. This, therefore, leaves

the question of the Coronium Spectrum still open.

We have during the last winter and summer attempted several times to excite the spectra of gases under a variety of conditions to look for the Coronium Spectrum. While it is difficult to say how far our experiments have been successful, we have observed a few facts which need recording. In all our discharge tubes when the pressure becomes very low, of the order of ·01 mm. or less and a powerful electrodeless discharge is passed, the whole visible region becomes practically free from lines, except for a few belonging to the secondary spectrum of hydrogen. As must have been observed by many, the production of these lines does not necessitate an external source of hydrogen supply and the minute traces of hydrogen evolved from the grease, etc., are enough to impart considerable intensity to them. One of these lines—one of the strongest in the secondary spectrum of hydrogen—is 5303·15 and another is 6375. We identify these lines with the two corresponding lines of Corona. There is *a priori* a strong case for the presence of hydrogen in the solar Corona, this being the lightest element, which, therefore, is expected to reach great heights. An examination of the spectroscopic data for the innermost transitions of most of the lightest elements on the basis of selection radiation pressure theory did not help us in any way except to strengthen the suggestion made here with regard to the presence of hydrogen.

The correspondence between 5303·15 and the coronal line is very close but the difficulty of the explanation of other lines still remains.

P. K. KICHLU.
B. M. ANAND.

Lahore,
October 31, 1932.

The Affinities of Chætognatha.

IN upholding the theory of the Annelidan ancestry of Chætognatha, Dr. John* attempts to explain the absence of a Trochophore stage in their development as due to the fact that they are pelagic. This explanation ignores the existence to-day of several pelagic forms (such as pelagic Mollusca and Crustacea) with a larval history. His analogy with the Oligochæta will not stand, for the Oligochæta have become so terrestrial that they do not go to water to lay their eggs and a free-swimming larval stage is not possible. Yet, even in them, a stage which can be compared to the free-swimming larvæ of other Annelids can be distinguished. The developing embryo bursts the vitelline membrane and floats in the albumen of the cocoon, feeding independently on it. A ring of delicate cilia surrounding the mouth and comparable to the prototroch has been distinguished in a species of *Lumbricus* and an adoral ciliated zone is recorded in the embryo of another genus (*Criodrilus.*) The embryos of the Oligochæta have in fact been described as degenerate larval forms.

S. G. MANAVALA RAMANUJAM.
Presidency College,
Madras.
November 1, 1932.

* *Current Science*, 1, 66, 1932.

Studies in the Life-History of *Balanophora indica*.

THE study of *Balanophora indica* was undertaken three years ago with the object of working out the life-history, germination of the seed and its further development.

Plate I.

An account of the development of the embryo sac of *B. indica* was read before the Botany Section of the Indian Science Congress, 1932, held at Bangalore. The work carried out so far is briefly summarised below :—

The development of the megaspore-mother cell and the embryo sac has been followed

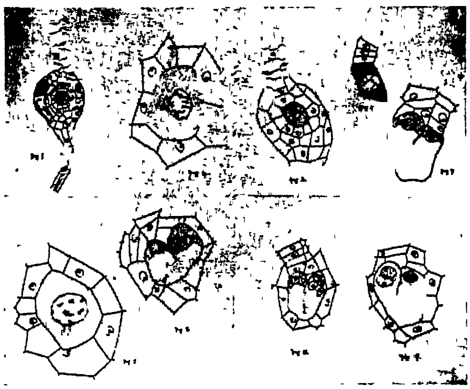

Plate II.

stage by stage (Plate I) and it closely resembles the description given by Lotsy[1] for *B. globosa*, except for the fact that the U-shaped embryo sac is rather broad with the two limbs being closely approximated. One noticeable feature is the presence of a row of three to four rectangular cells overlying the antipodal limb of the embryo sac, just the reverse in position of what Trube[2] has figured. Eight nucleated embryo sac is commonly found, the egg nucleus being not prominent. Several stages of the development of the endosperm and embryo have been observed (Plate II, Figs. 1, 2 and 3). No sign of pollen tube or fertilization has been noticed. Further study is in progress.

Regarding the microsporogenesis, the important features illustrated by figures (Pl. II, Fig. *a* to *o*) are stated here, the details being reserved for a comprehensive paper to appear elsewhere shortly. Microspore-mother cells are generally spherical in shape but some, however, retain their hexagonal outline. During meiosis, the nuclear membrane persists even after the diakenesis stage, disappearing only at the first metaphase stage. The chromosomes are short, thick and very small. At the metaphasic equatorial plate the chromosome number appears to be about sixteen. If this is confirmed by further observations, this number will coincide with that reported by Earnst[3] for *B. elongata*. Cell division by means of an incipient furrow is started at the end of the heterotypic division and does not progress further. In the second division the spindles are generally parallel but in some cases they are at right angles to each other. At the telophase and even later four groups of chromosomes can be noticed at the four corners of the mother cell, lying in the same plane. The formation of the daughter nuclei continues, leading generally to the the tetrad arrangement of the microspores.

L. N. RAO.

Department of Botany,
Central College, Bangalore,
September 1932.

[1] Lotsy, J. P., 1899, "Balanophora globosa Jungh," *Ann. du Jard. bot. de Buitenzorg*, Bd. 16.

[2] Trube, M., 1898, "Lorgane femelle et l'apogami du B. elongata," *Ann. du Jard. bot. de Buitenzorg*, Bd. 15.

[3] *Die zytologie der Blutenpflanzen*. 1926, p. 523, by P. N. Schurhoff.

Research Notes.

Width of the D Lines of Sodium in Absorption.

S. K. KORFF (*Astrophys. Jour.*, **76**, 124, 1932) has, by measurements on the D lines of sodium in absorption, shown that the contours indicate the theoretical variation of opacity with the inverse square of the wavelength distance from resonance and the variation of the width with the square root of the number of atoms in the line of sight. The conclusions are in agreement with the predictions of the radiation damping theory and also with the quantum mechanical theory of Weisskopf and Wigner. The experiment yields a new independent value for e^2/m as $(2 \cdot 51 \pm 0 \cdot 2) \times 10^8$, compared with the accepted value $2 \cdot 512 \times 10^8$. The effect of foreign gases on the width gives values of the effective "interaction radii" as 7×10^{-8} cm. for the Na-He combination and 2×10^{-7} cm. of Na-H_2, while Na-Na interaction radius is of the order of 10^{-6} cm. These results agree with the observations made in emission spectra of mercury arc in atmospheres of foreign gases by

Venkatesachar and Sibaiya (*Ind. Jour. Phys.*, **4**, 179, 1929) who state "that neutral normal atoms such as those of helium or normal molecules with negligible electric moment such as those of carbon-dioxide may be present inside the orbit of the optical electron without exercising appreciable influence on it. We, however, find when there is no admixture of a foreign gas in the mercury arc a pressure of 4 mms. has far more influence in not bringing out the higher members than a pressure of 40 mms. due to the introduction of carbon-dioxide." Korff's statement that hydrogen is far more effective than helium in broadening the line gives again the observation of Venkatesachar and Sibaiya that "When the arc is produced in hydrogen, a pressure of one centimetre produces the same effect in respect of widening the lines as a higher pressure say of 4 cm., when the surrounding gas is carbon-dioxide." The latter authors have also given the explanation for this observation. Korff has used 2·5 metre column of low density sodium vapour to make an approach to astrophysical conditions.

A Preliminary Note on the Development of *Rana tigrina*.

DR. M. L. SETHI, of Hoshiarpur, has made certain interesting observations on the extreme rapidity of cellular development and of the attainment of the larval stage of *Rana tigrina*. According to him, the frogs spawn in the early hours of the day during the breeding season, the morula stage is reached within an hour and a half after the eggs are laid; epibolic gastrulation, at the end of six and half hours: the neural plate and folds appear in about ten hours. The larvæ hatch out within twenty-four hours. This in his view is remarkable when compared with the developmental history of the English frog which takes usually a fortnight to reach corresponding larval stage. Dr. Sethi further mentions that the external gills appear within a day after hatching and hind-limbs sprout three days after and fore-limbs two days subsequent to this period. The metamorphosis is completed in thirty-eight days while in England frogs take from seventy-seven to eighty-eight days.

He further states that the development of a species of *Bufo* which inhabits Hoshiarpur area, the Punjab is on closely similar lines.

The Effect of Humidity on Supersonic Velocity in Air.

M. KINOSHITA AND C. ISHII have shown from thermodynamical considerations (*Tokyo. Sc. Papers.*, **19**, 83, 1932) the velocity V of waves, sonic or supersonic, in a real gas to be $V = \sqrt{p\beta\gamma/\rho\alpha}$ where p is the pressure, ρ the density, α the expansion coefficient, β the pressure coefficient and γ the ratio of specific heats. Considering both the air and the water vapour as real gases, the velocity in humid air becomes

$$V_h = V_1\ (1 + 0{\cdot}000210e)$$

where V_1 is the velocity in dry air and e the vapour pressure in mms. of mercury. Using a valve oscillator for exciting oscillations in a rectangular quartz plate of Curie-cut and a thermohygrostat, the authors have obtained results in the supersonic range which can be expressed by

$$V_h = V_1\ \{1 + ({\cdot}00023 \pm {\cdot}00001)\ e\}$$

In conclusion they draw attention to the applicability of this relation to practical hygrometry. The advantage over all other hygrometric devices consists in the possibility of measuring the humidity in any limited space without disturbing the condition of the air in the enclosure.

The Chromosome Number in Sphenodon.

R. D. KEENAN has given an account of the chromosomes in Sphenodon Punctatum (*Journ. Anat.* 1932). According to him, "the number of chromosomes in the spermatogonia of *Sphenodon* is 36, *i.e.*, 12 V- or J- shaped, 16 rods, two very short rods and 2 micro-chromosomes. The equatorial metaphase plate of the first division shows 18 tetrads, 6 of which have an atelomitic attachment of the spindle fibre and the remainder a telomitic attachment. The atelomitic tetrads are similar in structure to the anaschistic V-shaped tetrads of other Reptilia and also to the ring tetrads of the Orthoptera. The telomitic tetrads usually appear as equatorial rings. Secondary spermatocytes were rare but one observation on the second division at anaphase showed clearly the presence of 18 elements, *i.e.*, 6 V-shaped, 9 rod-shaped and 3 dot like. From the observations made, it is highly probable that the male is homozygous in respect to sex, the condition of the chromosomes being XX. Applying the theory of Robertson concerning the formation of V-shaped chromosomes to those of sphenodon, it is possible that the

primitive number of chromosomes in the reptilian order is 48. It is suggested that the chromosomal formula of the Autosauri has been derived from this primitive number principally by a reduction in the size of the individual elements."

Study of Mountain Structures.

"THE Application of Mechanical Structural Principles in the Western Alps" forms the subject of an interesting paper by Andrew Leith recently published in the *Journal of Geology*, Vol. IX, **39**, 1931). After giving a brief review of the generally accepted hypothesis regarding the origin of the Alps based on stratigraphic, lithologic and palæogeographic evidences, the author states that there is generally a complete neglect, in these hypotheses, of mechanical structural factors. The need for employing such evidence in the elucidation of obscure problems of Alpine structure is emphasized and numerous examples are given where the author has applied such mechanical structural evidence successfully in the "Hautes Alpes Calcaires" of the Western Alps.

Histology of the phloem necrosis of Potato.

"A STUDY of the histological changes resulting from certain virus infections of the Potato" forms the subject of a well-presented paper, recently published (*Proc. Roy. Soc.*, Ser. B., **3**, No. 769) by F. C. Bawden. After giving a brief reference to the previous works on the subject from 1913, the author gives a short description of the anatomy of the healthy stem of potato with its isolated groups of inner phloem and the outer phloem which becomes linked up with the formation of the secondary phloem. In the mature plant there is a considerable amount of secondary phloem. The wall of the sieve tubes sometimes becomes slightly thickened with cellulose but shows no pathological changes. The author agrees with Quanjer's division of the Streak Disease into two main groups, *e.g.*, Acronecrosis or Top-Necrosis and Acropetal Necrosis or Leaf Drop Streak. In top necrosis, necrotic spotting of the upper leaves followed by the dying of the plant from top downwards form the main external feature. Internal symptoms are started in the petioles, stem and tubers and consists of necrotic changes in the phloem. In the tubers and stems grown at high temperatures, phellogens are formed round the necrotic areas. The external symptoms of Acropetal Necrosis are crinkling of the upper leaves, necrosis and falling of the lower leaves. Internal symptom consists of necrosis affecting chiefly the collenchyma as seen generally in the stem and petioles. The necroses are produced in the phloem of plants suffering from leaf-roll in the year following that of infection and are restricted to the phloem elements and consists in lignification. No necroses were found in the virus free stem or petiole.

The Menstrual Cycle of the Primates.

THE fifth part of this very important series of papers on the "Menstrual Cycle in the Baboon" by Dr. S. Zuckerman and Dr. A. S. Parkes (*Proc. Zoo. Soc.*, 1932, Part I) embodies the results of an investigation into the morphological changes in the reproductive cycle of the female baboon as evidenced by an examination of twenty-one specimens of both species, *Papio hamadryas* and *P. porcarius*. The cyclical changes are essentially the same in the two, except for the greater size of the non-pregnant uterus in the Chacma species (*P. porcarius*)—which in all probability can be accounted for by the larger size of the animal itself—and its deeper endometrium. An examination of the general morphology of the reproductive organs reveals that the baboon corresponds to the type found in the Old World apes and monkeys. During the course of the cycle the region surrounding the anus and the external genitalia swells to form the "sexual skin", which, undergoing cyclical changes itself, acts as an excellent external indication of the very complicated internal phenomena. Its history can be said to begin soon after menstruation has set in, when it swells very soon attaining a maximum size. Suddenly, however, it is seen to subside and become quiescent. This coincides with the rupture of a ripe Graafian follicle. The skin remains in this condition till the onset of the next menstrual bleeding.

The ripe Graafian follicle of the baboon is quite large, the largest measuring over 6 mm. in average diameter. It is noticed that the history of the growth of the follicle can be divided into two phases: first, when the oocyte and the follicle grow together and subsequently, when the ovum ceases to grow while the follicle continues to. As soon as the ovum is extruded, along with a

large quantity of liquor folliculi, the thecæ rupture and their tongues project into the ruptured follicle dividing it into lobes. By this time the granulosa cells are slowly being transformed into luteal cells. The rupture of the follicle which is coincident with the subsidence of the sexual skin at once initiates the formation of the corpus luteum and three days later it is seen to be definitely formed. Very soon and very rapidly, however, it degenerates and, by the time the next luteal phase is established, it is hard to be distinguished. The history of the corpus luteum in the pregnant animal, on the other hand, has not been worked out so thoroughly, due, probably to lack of material. It is, however, noticed that the corpus luteum of pregnancy is the largest in the entire cycle; but it is not known when the degeneration of the corpus luteum of pregnancy takes place.

Menstruation in the baboon consists of a destruction of the outer two-thirds of the endometrium accompanied by profuse bleeding. The ruptured glands and their secretion, clumps of stromal cells and patches of surface epithelium constitute the debris. There does not, however, seem to be any uniformity in this isolation of the uterine epithelium and a part of its underlying endometrium, for different regions of the uterus are involved at different times and in different degrees. First the stroma is destroyed and the glands are affected later, consequent on the sequestration of the tissue in which they are lodged. Very early in the follicular phase the endometrium is regenerated. Though the exact nature of this regeneration process has not been ascertained, it is certain that even in the later stages of the menstrual process the surface epithelium is restored everywhere. The glands are straight, long and tubular and there is no secretion in their lumen. The regeneration of the endometrium continues during the ensuing luteal phase when the stroma becomes oedematous and the glands are extremely long, coiled and distended with secretion. The changes that occur in the uterus after parturition are not found to be very different from those in the uterus of the common macaque and man. During this phase the endometrium is very shallow and the ovaries inactive. The presence, in this stage, of a large quantity of debris in the uterus of the nursing animal has not been accounted for, unless it is assumed that a degeneration of the endometrium and the myometrium takes place during nursing.

The vagina in the non-pregnant animal has a greatly thickened and keratinized epithelium. During the luteal phase the cell layers are gradually sloughed off till at the beginning of menstruation the ragged surface left by the desquammation is repaired and the epithelium consists of a thin layer. During menstruation again the vaginal epithelium is thickened and cornified. This continues through the follicular phase leading to the typical corrugated epithelium seen just before ovulation. During pregnancy, especially during its later stages, large mucin cells are seen to develop in the crypts of the vagina. After parturition the vagina lapses into a state of inactivity.

In the non-pregnant animal there is little change observed in the mammary glands. In fact their functional activity starts from the moment of parturition but they atrophy if suckling is discontinued. Available evidence makes it possible to believe that the mammary glands are permanently active.

A Scheme for Advancing Scientific Research in India.

By P. W. Gideon, *Karnatak College, Dharwar.*

SCIENTIFIC research in this country is comparatively young, and it is unfortunate that when India has just begun to encourage research of definite economic value there should be a setback in the form of financial stringency. As a result, valuable research work in Agriculture and Medicine, which has brought definite material prosperity to the country is likely to suffer, unless some scheme is devised for still encouraging and financing such work. The following is a suggestion put forward in the hope that, not only those who are engaged in research, but also those who are interested in the economic value of the results of such research, will do all in their power to encourage such work in India.

The majority of colleges teaching Science in India are really free centres for research, having trained men with leisure for such work, and well-equipped laboratories at their disposal. Might not a request be made to the Government of India that they invite, through Provincial and State Governments, the services of these men to work on research problems which have a direct economic value from the Agricultural, Medical, and Veterinary points of view? Most colleges teaching the science courses for the I.Sc. and B.Sc. examinations have laboratories equipped for research purposes and the majority of the members of the staff are expected to interest themselves in research work. The

average number of hours of work for those teaching up to the B.Sc. standard is 12—15 per week, and for those teaching up to the I.Sc. standard 10—12 per week. The men appointed as Professors, Lecturers and Demonstrators in these colleges are trained in research methods, and eagerly take up teaching as a profession because of the prospect of continuing research in the subjects in which they are interested. There are, however, instances of men, who for want of sufficient encouragement (chiefly financial), are forced to content themselves with the ordinary daily routine expected of them as mere teachers.

With such excellent material, equipment and personnel at their disposal, it is a matter for regret that the free services of these trained men and their well-equipped laboratories have not been sufficiently exploited by the Government of India in the solution of problems of value to the Agricultural, Medical, and other departments.

The majority of these trained men are utilizing their spare time in doing valuable work of a purely academic nature in every branch of science. Leaving this type of work to the great University centres, the present scheme would organize the other trained men scattered in colleges all over India, so that their methods of research could be utilized on problems of economic value to the country. So far this side of research has been left to a very small section of scientific men in India, working in recognized research centres.

In the Bombay Presidency there are at least 16 colleges teaching science. Leaving the Royal Institute of Science in Bombay to carry on research work from the academic point of view, the remaining 15 colleges are admirably situated in very important areas and would form excellent centres for research. No doubt the same would apply to colleges in other Presidencies, Provinces and States.

Such a scheme would mean that mofussil colleges would play a very important part since being few and far between they would have to deal with comparatively large areas abounding in problems which must be studied in their natural surroundings. In such inexpensive centres of research, supplemented by comparatively small annual grants for the purchase of literature and apparatus suitable for the particular problem undertaken, important investigations might be carried out and desired results obtained, whereas otherwise, these problems might remain unsolved for want of large sums of money for the erection of special research buildings, the employment of special staff and the purchase of special apparatus.

As regards the trained men available, there are in each science college at least three departments useful for purposes of economic research, —the departments of Zoology, Botany, and Chemistry. In Intermediate Colleges of Science there are at least four men available for such work, and in colleges teaching the degree classes at least three men in each subject are available.

The fact that the Imperial Council for Agricultural Research allots a certain amount of money as research grants to various trained men in colleges proves the value of the work done by these men. In the present state of economic distress it would appear that much of this valuable work would have to be stopped. The scheme now outlined would enable this research work to be continued on a more intensive basis and with practically no additional cost to Government.

Keeping in view the necessity for retrenchment and strict economy in expenditure, and at the same time the need for increasing the revenue of the country, it might be in the interest of Government to consider the proposal as follows :—

Create a central board consisting of representatives of the Educational, Agricultural, Medical and Veterinary departments of the Government of India, which will

1. Invite Provincial Governments and the Governments of Indian States to co-operate in the economic progress of the country by:
   (*a*) ascertaining from all Government and Private Institutions teaching Science, the number of men willing to carry out original investigations of a definite economic value, together with particulars regarding the branches of study in which they have specialized,
   (*b*) classifying these specialists as under Protozoology, Entomology, Plant Pathology, etc.

2. Invite all Central and Provincial Agricultural, Medical and other departments to submit important problems, which they have not been able to undertake for lack of money, but which in their opinion if investigated, would mean a definite gain.

3. Classify these problems:
   (*a*) Scientifically, as under Zoology, Botany, Chemistry, and their sub-divisions.
   (*b*) Geographically, so that colleges nearest to the affected areas be invited to undertake the investigations.

4. (*a*) Calcuate the approximate annual grants that may be required for carrying out these investigations in such colleges as are willing to help.
   (*b*) Ascertain the amount of money each department (Agricultural, Medical, etc.) would contribute towards the investigations suggested by them.
   (*c*) Invite contributions from commercial bodies who would benefit by such investigations.

5. Consider the desirability of asking Universities to recognize such centres of research for post-graduate work, so that members of the staff engaged on such problems may take the free services of students to help in the investigations, and on the strength of such work students may be allowed to submit theses for the M.Sc. degree. Such a system will not only solve the problem of employing paid assistants, but also will be producing University men trained in research methods of a definite economic value.

6. Consider the desirability of closing down smaller research establishments, and retrenching in bigger research centres such problems as can be investigated on a cheaper and yet as

efficient a basis in the various college research centres. A very small proportion of the money thus saved could be distributed as small annual grants to those undertaking problems in science colleges.

7. Invite recognized research bodies like:
   (a) The Imperial Council for Agricultural Research,
   (b) The Zoological and Botanical Surveys of India,
   (c) The Imperial Forest College,
   (b) The Indian Central Cotton Committee,
   (e) The Indian Science Congress,
   (f) The Indian Medical Council,
   (g) The Imperial and Provincial Agricultural Research Institutions, and other scientific bodies to co-operate by giving such help (financial or otherwise) as would enable the Central Government to formulate a scheme of work as would effectively cope with the present needs of the country.

Such a co-ordinated effort for carrying on an intensive research from an economic point of view will mean not only less money spent on research work but also added interest to so many trained men whose energy, training and time have hitherto not been utilized. This scheme would be within the strictest bounds of economy and would produce results of immense importance to the economic development of India.

A Marine Biological Station for India.*

By C. Amirthalingam, B.Sc. (Lond.), Ph.D. (Lond.),
Late Research Officer, Andaman Fisheries.

THERE is no doubt whatever that Marine Biological Stations in India are essential for advancement of Science and its successor, the economic exploitation of the sea. At the present time, there are facilities for marine research in the University of Madras and in the Madras Fisheries Department. As there are already places on the East Coast for research as such, one on the West Coast will be a great asset. As regards the centre, it may be said that Bombay is one of the suitable places, although in 1926, Col. Sewell initiated a five-year plan for the Zoological Survey of India, in which a Marine Biological Station was to be established in Karachi, but which was temporarily suspended due to financial reasons.

Among the problems that a station such as this will take up, will be the whole question of suitable methods of obtaining the maximum catch with the minimum cost of money and energy as it is not safe to assume that the appliances used in the West will be equally successful in Indian Waters. Thus, there is every possibility that great improvements will be made in the methods employed by our fishermen to-day. One has to look at Japan to know what great scope there is to develop the marine resources on Western lines to suit local conditions.

The value of the fisheries will depend not only on the quantity of fish caught but also on the quantity sold fresh or preserved for food and on the by-products such as oil, fishmeal for manure, etc. Hence *pari passu* with the improvement of fishing methods, marketing facilities, etc., must be developed, on the lines similar to those of the Madras Fisheries Department.

There is one important suggestion worth considering and that is the economic research must have a pure scientific basis. This will be best achieved if both the scientific and economic sides of the question are studied by *different* officers in the same biological station, thus ensuring a healthy co-operation and free exchange of ideas. The importance of this is borne out by the fact that fishery work has been carried on in Madras for about twenty-five years, but little research as such has been accomplished, as the time of its officers has been absorbed by administrative duties: in spite of this handicap the department has collected some valuable data and obtained good results.

The importance of knowing the bionomics of the animals is emphasized by Dr. Setna himself who states, "Our fishermen—and even we people with scientific training—know practically next to nothing of the migratory instincts of the fishes, etc." Here, one should not forget that data will be needed not only on the study of fishes with reference to the breeding season, rate of growth, food supply, and other factors but also on the questions of salinity, temperature, chemical composition, and movements of the water mass that wash the Indian Coast *at all seasons of the year*.

Further in a marine station, facilities will exist to work out in detail the morphology of the common animals to provide the necessary books for teaching. It is this want of text-books, dealing with Indian types, that is mainly responsible for the deplorable state of affairs as stated by Dr. Setna regarding specimens from Europe. Here one may refer to the fact that the essence of teaching science is not to cram the student with a mass of facts but to develop the powers of observation and logical deduction and text-books are to serve as mere guides to the student. Thus as the text-books used in various colleges are those dealing with European species, the institutions had to resort to importing specimens for the class-rooms. This number will die a natural death when a few more custom appear of the series entitled "The Indian Zoological Memoirs" which was initiated and is edited by Prof. Bahl.

As Dr. Setna suggests "the income of the station will be derived from (1) admission charges to the aquarium, (2) supply of marine specimens to places inland, (3) rental of tables"; it is submitted that the last item should be kept as low as possible for individual workers and especially the under-graduate, as it is not advisable to increase the cost of training; whereas

* *Cur. Sc.*, 1, 108, 1932

institutions may be approached to contribute annually towards the upkeep of any particular table.

In conclusion, the importance of the establishment of a Marine Biological Station in Bombay cannot be over-emphasized and special attention is to be paid to scientific research as a basis for economic exploitation of the Indian Waters.

The British Association—York Meeting, 1932.

THE Presidential Address of Sir Alfred Ewing at the York Meeting of the British Association is a very human document. Full of years and honour, Sir Alfred has known the Association almost from its very inception and gives a graphic account of the early days and the state of science then, contrasting it with the present conditions and outlook. He shows how a proud sense of scientific certainty has given place to a more humble, questioning spirit which recognizes that we are yet groping very much in the dark and that "to understand is to draw one incomprehensible from another incomprehensible" as Einstein put it. This humility has brought science nearer to the layman who shares in the desire for truth ; the social and economic problems of the day make him look wistfully to science for a satisfactory solution. The British Association has helped the advance of science by providing a common meeting ground for experts in different branches of science and Sir Ewing gives a famous instance of this in the fruitful association it brought about between Joule and Thomson. He also shows how the British Association was the first to try and give a sound scientific basis to British Engineering practice, mostly empirical before. The standardization of electrical units is another of its services.

After mentioning the most recent advances in our knowledge of nuclear structure due to the work of Chadwick and Cockcroft and Walton, Sir Alfred Ewing passes in review the many wonderful inventions whose birth he has witnessed, such as the dynamo, the motor, the internal combustion engine, the aeroplane and airship, the turbine, the gramophone and wireless. He emphasizes that modern invention has had such rapid progress because it built upon sure scientific knowledge and not on accidental discovery. This rapid increase of inventions has brought many amenities to the lives of men, but the consequent change in the methods of production and distribution has also upset the balance of human relations so that unemployment, competition and war have become a standing menace. Sir Ewing rightly concludes by a note of warning against allowing such a condition to develop ; as he says, we can only hope that man will not encompass his own destruction by wrong application of his God-given understanding, but that science will help him to enjoy the luxuries which science creates, in a manner leading to the elevation of his soul.

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The Presidential Address to the Section of Mathematical and Physical Sciences deals with the application of physics to a problem of economic and national importance, namely, the discovery of valuable deposits such as minerals or oil, without actual digging or boring. It is a subject which, for its development, requires the co-operation of physics and geology, involves team-work in the field and is costly to pursue. Yet judicial application of the methods developed by workers in this field often leads to a considerable decrease in relative costs, and further improvements may in future lead to greater reliability and cheapness. Being an infant science which cannot attract public attention through sensational discoveries such as are being made in atomic physics, it is likely to languish for want of support: Prof. Rankine justly emphasizes the need for Government help at such a critical stage of its life. Leaving aside such appliances as the divining rod, whose action, even if real, is not based on known scientific principles, the methods at present available are four, *viz.*, gravitational, seismic, magnetic and electrical. In the first method, the extremely sensitive torsion balance invented by Baron von Eötvös, is used to study the variations in gravity due to variations of the density when layers of different minerals are present in any locality. The instrument though costly, is very reliable, and its indications will lead to valuable results, unless topographical irregularities are so large as to mask the effect of mineral deposits. The seismic method is particularly suitable when there is a horizontal separating layer between two extensive deposits in the lower of which the seismic wave travels faster than in the upper. In such a case the disturbance due to an explosion travels to the separating layer and being refracted or diffracted along this, reaches the surface at a large distance earlier than the direct pulse travelling along the upper deposit. Hence a delicate portable seismograph will be able to record it so that it is not masked by the larger perturbations due to the direct wave. When iron-bearing deposits are concerned, the magnetic method, which depends on measuring the variations of the horizontal and vertical components of the Earth's magnetic field by means of a portable magnetometer, is most suited and is least costly. The method will be even more useful when the magnetometer is improved as suggested by Prof. Rankine by utilizing the torsion principle used in the Eötvös balance and thus making it more sensitive and at the same time less liable to disturbances due to daily and temperature variations of the magnetic field. The possibilities of the electric method, in which the variations in the electrical conductivity of different layers are measured, have not yet been fully explored. In fact, the method was shrouded in mystery before the publication of the Report of the Imperial Geophysical Experimental Survey. But in future, when other nations besides the Germans, who have so far been almost the sole cultivators of this science, devote their attention to the problems of Geophysics, the electric and other methods may confidently be expected to be enormously improved and the science firmly established among other branches of applied physics.

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In his presidential address to the Section of Agriculture Prof. R. G. White gives a succinct history of the growth of Sheep Farming in England. From very early times, dating as far back as the Norman conquest, sheep farming has always remained a substantial source of the British farmer's agricultural income and statistics for the year 1930 show that except for New Zealand, Great Britain holds the eighth rank in the sheep population of the world and a third of the world's sheep are from the British Empire.

The importance of sheep farming is no new feature of British Agriculture. Throughout the middle ages and upto the middle of the fifteenth century, England was the most important source of the supply of wool required by the continental manufacturers. The export duties levied on these outgoing supplies were among the most important sources of revenue available for the mediæval equivalent of the present Chancellor of Exchequer. The industry received a definite stimulus by the various enactments which prohibited the export of wool with a view to have all the British wool for the British looms. Legislation was not the only means to foster woollen manufacture. Definite encouragement and attractive inducements were offered for foreign weavers, particularly Flemish, to come and settle in different parts of England.

The development of woollen manufacture, the consequent heavy demand for wool and the increase in the industrial population contributed not a little towards the rapid strides in the agriculture of the country, particularly sheep farming. To meet the growing demand for wool and to provide food for the growing industrial population, the population of sheep had to be increased which brought in its train the necessity for converting arable land into sheep pastures and the development of mountain sheep farming.

Discussing the present status of the sheep industry in England, Professor White suggests directions in which the future developments are possible. His first suggestion is to increase the return per unit of flock, particularly when England has to depend for its supply of meat from January to May on outside countries. He further suggests methods to make better use of the ewe's capabilities of production by an increase in the lamb crop. With some more useful and economic suggestions for the improvement of sheep farming in England, the President makes a definite case for regarding sheep farming as a distinctive feature of British Agriculture.

* * *

Lord Rothschild in his Presidential Address, makes out a very vigorous case for the Systematic Biologist whose work, unlike the common prevalent notion, is really one of great difficulty yielding results of equally great importance. Applied Biology would be helpless without the assistance which Systematic Zoology constantly renders it. The identification and distinction of species is a matter of paramount importance, for not only structural differences are implied in such a distinction but differences in their behaviour as well. It should not be forgotten that it was a systematist that made the very important discovery that while *Xenopsylla cheopis* is the rat flea that carries plague, the allied *X. astia* is a very inefficient carrier of the disease. The bearing of this distinction on the determination of the history of the disease was found to be very close.

The work of the systematist does not merely consist of a study of species and their varieties only. The grouping of species "into genera and then into higher categories, all according to relationship" is the more important part of his work. He must enter upon Geography also throwing light on the affinities of species and genera with regard to their Geographical distribution. He must take into account ancient forms and must be able to determine their relationship with the History of the Earth. Though the systematist is more concerned with the organisms produced by Nature than with the active forces that created or evolved them. for a definite and real understanding of the diverse processes going on in Nature, the systematist with his large collections of organisms and his expert knowledge at the grouping and determination of these organisms into their different classes is of inestimable value.

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In his Presidential Address to the Section of Archæology, David Randall MacIver says that the advent of the science of archæology in England is almost contemporaneous with the announcement of the "Origin of Species" by Darwin and Wallace. It was in 1850, a few years prior to this great epoch-making discovery, the subject of Archæology was founded and in the succeeding years definite steps were taken to unravel the hidden mysteries. It is usually accepted that the scientific aspect of this interesting subject drew its inspiration from the subject of antiquary, and like anthropology archæology is a very young science both of them being closely allied. They deal with man but from different aspects. Anthropology which is the wider of the two deals not only with "man's material works but also his mental moral and sociological developments", while the "interests of archæology is solely in those works which can only be produced by man when he has become more or less sapiens". This is rather a conservative definition, for certain remains of flints antidate any actually known remains of man,—the researches of this science extending as far back as the tertiary. After that it is only about 3500 B.C. that inscriptions and documentary evidences are found. The organization of the subject consists in the collection of the material, conservation and exhibition and then popularizing it. For the collection of material an able body of scientists with the consent of Government authorize an expert to be in sole charge of an expedition. As soon as the exploration is over a publication incorporating the various aspects of the exploration must be made in a suitable manner. The findings must be properly arranged and exhibited in a museum. Such a scientific collection need not be further amplified by decorations. Having described these aspects of archæology the President discusses in a lucid manner the principal problems like the application of a time scale and the dissemination of a culture. A relative chronology has been established from earliest times and these culture periods require proper definition in terms of years. Thus the products of Egyptian civilization have been dated and with reference to this the others are measured.

In his Presidential Address before the Botany Section, Prof. J. H. Priestly laid stress on the importance of the botanical study of trees which do not receive adequate attention from the botanists. Trees do not form a special botanical category, but they are often regarded as the special study of the forester rather than the botanist. Utilitarian side gave the first impetus to the scientific study of botany and botany still finds in agriculture and forestry its contribution to make in the service of mankind. He felt that the recognition of this practical significance would vitalize botanical teaching. He agreed with I. B. Balfour that the study of growing trees throws fresh light upon its form, structure and vital functions and gives new meaning to the practice of the forester and horticulturist whilst details of structure which attract the attention of the worker in wood are also seen in new perspective. The tree is characterized by prolonged vegetative growth and delayed reproduction. In the growing season growth takes place radially in the woody axis and in length in all the branches. These two are not separate functions but are inseparably and casually connected. In dicotyledons and gymnosperms growth process continues to thicken the axis after it has extended in length. The address gives a detailed account of the shoot apex, the development of the leaf primordia, the vascular connection with that of the axis, the formation of the cambium, and its continuity with the apical meristem of the basipital cambial activity from the buds suggested by Hartig so long ago as 1862, along with its practical bearing in forestry and horticulture. The varied details of this phenomenon have proved exceedingly interesting and there is no doubt that the new technique followed to study the above process has much to tell us of the characteristic of the radial growth in different trees like the ring-porous type and diffuse-porous type of woods of oak and beech respectively. Further, the fact that the tree-form and structure is dominated by this causal link between bud development and radial growth has been very well treated with common examples. The subject of vascular differentiation in the soft and hard woods has been dealt with in detail. As the cambium cylinder grows wider the relative readjustment of position in the cambial cells takes place by "Symplastic" movement of the common frame work of walls of the fusiform initials. Then the surface of the wood comes to be clothed throughout its entire length with a new layer of wood which originates and spreads from the base of the extending foliage shoots. If the buds on the lower branches fail to grow, cambial activity also fails in these branches. It is from this point of view, the movement of food and water in the tree must be interpreted. Water movement through the tree is associated with the growth of the tree. The mechanism of movement is inseparable from the process of growth and differentiation, and the movement is not equivalent to the passive flow of water, the sap wood acting as a reservoir of water. So long as the cambium is still growing, the downward movement of organic materials in the tree must be clearly connected with those growth processes. There is very general agreement that the phloem plays a role in this movement. It may be that subsequently in fully differentiated sieve tubes, companion cells, etc., translocation of food still takes place, but on the other hand, the structural features of the adult sieve tube may rather be analogous to those features in a dry river bed which supply evidence that it was once a channel for rapid flow of current. These statements show that the intriguing problems of the growing tree are not only of interest to the students of science but also of profit to the forester and the horticulturist. When we see the wooden materials fashioned to our service which surround us on every hand, a knowledge of the story of the way in which they came into being will surely add to our pleasure in them.

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In his Presidential Address to Section C. (Geology) Prof. P. G. H. Boswell has given an admirable account of the relationship of early Man to well-established geological phenomena in the Ice Age—a very fascinating field of study on the border line of Geology and Archæology. The earlier part of his address deals with the intrinsic value of a study of the subject of Geology and the position which this subject should occupy in any curricula of studies in our schools and colleges. It is needless to say that, coming from such an eminent educationist and well-known geologist, these ideas are worthy of serious consideration by all people interested in the cause of true education. "For the breadth of view which it engenders and the enthusiasm it inspires", Prof. Boswell considers that Geology ought to find a place in the curriculum of every university student (as it used to in the Royal College of Science and still does in at least one American university)—a view that has been even more emphatically expressed recently by the Prime Minister when he said: "If any one of the sciences were selected as the key to all the other sciences, as that which in its subject-matter and its history, the history of its evolution, enforces the true scientific method, Geology might be selected as that science. For it touches all the fundmental sciences; it teaches the young how things become, how age merges into age, how species merge into species, how generation merges into generation, institution into institution—in short, how to approach that problem of a working and progressive society by making them acquainted with the processes of earth structure and of life lived on that structure."

Out of the several contacts of Geology with other sciences, Prof. Boswell's address on the "Ice Age and Early Man in Britain" deals with field where Geology is able to help in the spirit of pure investigation, without any practical applications or utilitarian reward. In the light of recent evidences, it is obvious that the older idea of the advent of Man on the earth's surface being considered a post-glacial phenomenon must be abandoned, and we must realize that Man was a contemporary of the mammoth and the straight-tusked elephant of glacial and inter-glacial times. It must, therefore, be possible to co-ordinate the evidence of Man's activities with that of the advance and retreat of the glaciers; and it is with this interesting subject that Prof. Boswell's address essentially deals. For this purpose he has selected a number of areas in Britain where a thorough investigation of post-tertiary geology has furnished evidences for the contact of early Man with stratigraphical horizons. He begins with East Anglia where

he considers we get the standard succession of glacial and other deposits associated with the remains of early Man. Other areas like Lincolnshire, Yorkshire, Northumberland and Lake District, the Irish sea and Cheshire basin. the Avon-Stour area, and the Upper and Lower Thames are next considered, and in each case, a very detailed account has been given of the several horizons of deposits in their stratigraphical order, together with the nature of the associated stone implements. Most of this descriptive account of local geology will be considered rather dull reading by the average layman, although to the serious student of the evolution of early Man, the wealth of information embodied in these descriptions is of utmost interest and value. An attempt at correlating the observations made in these different areas so far as Britain is concerned, has been made and the author feels that it is impossible to go any further in this line of work for "it would be premature to attempt world-wide correlations of the geological and climatic phenomena accompanying human industries". A fact of general interest that emerges from these studies is that according to Prof. Boswell "whatever the cradle of Man may have been, Asia or Africa, the evidence of prehistoric stations shows that the waves of his successive migrations advanced north-westwards across Europe. * * * His advance was determined by the extent to which the country was ice free; for we find that successive human industries extend farther northwards and north-westwards as the ice retreated, although the readvances of the glaciers and flooding of the country temporarily drove the invader back." By studying the several areas in the particular order which he has followed Prof. Boswell has shown that the sequence of human industries—pre-Chellian, Chellian, Acheulian, Mousterian, Aurignacian, Solutrian, Magdalenian, Tardenoisian, and Neolithic when traced north-westwards across England display, as must be expected, the phenomena known to geologists as overlap "the newer deposits and human waves would extend farther than the older, as the area was opened up by the retreat of the ice."

In view of the fact that the field covered by the address is one in which pioneer work is still being done, there is no doubt that an address like the present one embodying all the recent work carried out in a country which has provided exceptionally valuable information in the study of early Man, will be of very great value to all future workers in this line.

Two Convocation Addresses.

MYSORE UNIVERSITY.

DEWAN BAHADUR SIR C. V. KUMARASWAMY SASTRY'S Address, delivered last month at the Convocation of the Mysore University, is in several respects an important and interesting public utterance on some of the Educational topics which are usually omitted on such occasions. It is true that, as is common to all Convocation addresses, there is in this also a fairly generous appeal to the graduates to develop their character, to maintain their religion and morals and not to forget their own language and the glorious heritage of India. But so far no one has had the candour to dwell on and vindicate the eminent learning and usefulness of the Pandits, who, on the other hand, are generally condemned, chiefly through prejudice and ignorance. Sir Kumaraswamy Sastry is a conservative by constitution and in the course of his long public service, has developed a cautious attitude towards all public questions. But his condemnation of the uneducational practice of frequently changing the text-books in the different grades of instruction whose character and content provide neither information nor intellectual discipline, is at once refreshing and timely. He pleads with the ability and skill of an advocate, the cause of the poor and middle-class students who, on account of the excessive cost of education, are unable to participate in its advantages. But by far the boldest utterance in the address relates to the utterly stupid curriculum of studies pursued by Indian women students. His views on the ideals of womanhood apparently belong to a bygone age and he has no sympathy with those who advocate equality and liberty for women. His reference to the failure of scientific education to promote peace and goodwill among men is, we are sorry to be obliged to say, proceeds from an inadequate conception of the purpose and ideals of science. Science ought not to pretend to promote human happiness or to destroy it though its results might be used or prostituted for either purpose; but its main ideal is to give its votary a strict discipline of truth and open out new visions of the ultimate reality. In spite of a certain lack of what critics might call modernism in the views of Sir Kumaraswamy Sastry, on some major questions of education, the address taken as a whole, is a most notable pronouncement.

M. S. M.

THE ANNAMALAI UNIVERSITY.

The Second Convocation Address of the Annamalai University was given on the 27th October by Mr. R. Littlehailes, Director of Public Instruction in Madras. It may be said at once that it is a clear pronouncement on some of the subjects with which he has dealt. He says, "I could considerably expand this (the old educational policy) as well as other aspects of educational administration, but I do not consider the present to be either the time or occasion to develop at length views on education in India." If, instead of imposing upon himself the self-denying ordinance, he had pursued the course of his natural impulse to expound the progress of education and achievements of his department, we should doubtless have gathered much valuable and authoritative information. Everyone who is interested in the growth and expansion of education and the output of the right type of men from the educational institutions, will be grateful to Mr. Littlehailes for calling public

attention to the fact that the role of parents in the education and development of character of their children is far more real and earnest than that of teachers, and for properly exercising this most important function, the atmosphere of students' home must be cultured and elevated. Dealing with that much-abused termo, "democratisation", he clears the prevailing confusion of thought in the public mind and points out that democratisation of education is good in the interests of the community and democratisation of the department of education and of the Universities is fraught with danger to both. One will readily agree with his contention that the management of the Universities must remain in the hands of intellectual aristocracy and if this point were pushed a little further, we arrive at the conclusion that the civilian officer, however eminent and generous, is not best qualified to direct and control the fate and fortune of the education of one-fifth of the human population. The fact about education in India is that the power of formulating its policy is in the hands of well-meaning distinguished civilians but which ought to be really entrusted to those who have lived and acted education and have their being in education. Those in charge of the education of the country's youth will welcome Mr. Littlehailes' exhortation to the graduates and possibly to the under-graduates who must have been listening to him, to remember the difference between freedom of thought and freedom of action, the latter presumably including freedom of speech. There is so much flatulent rhetoric in the country filling the minds of people with the turbulence of a south-west monsoon that he would have been perfectly justified had he devoted some time to point out to the young men who are about to enter the world, the need for electing their legislators who give proof of their wisdom, balance, moderation and constructive power rather than a capacity for oratory. Mr. Littlehailes in referring to intellectual snobbery would have been right, had he dwelt on the unnatural gap between the educated classes and the less fortunate rural people, which it has created and had discussed the means and the methods of removing it; but by referring to the immensity of space and worlds in the celestial system, he preferred to convince the graduates before him that each one was not greater than the speck of dust in the room in which they were seated. Rather they should have been told that modesty is an inherent character of good-breeding, the direct outcome of true University culture and an offence against it virtually constitutes an indictment on one's inherited good qualities and the efforts of one's institution to improve them. If Newton and Darwin were models of modesty, it was because they were appalled by the enormity of their ignorance compared with the immensity of knowledge before which they stood like children and not because they were convinced that they were a speck in the vastness of cosmic space. After all egoism is a quality of the human mind and the whole celestial system falls within its province. Moreover, an amiable touch of that quality would seem almost indispensable to an enterprising and intrepid mind when it sets out to extend the boundaries of human knowledge by making fresh conquests. Every one that is interested in the progress of the country will sympathize with Mr. Littlehailes' plea for the cultivation of the vernaculars to be used as a vehicle for conveying profit and pleasure to the masses, and this is possible provided caution is exercised against the tendency of even the modern vernaculars becoming too learned and classic for the ignorant rural population. The Annamalai University, everyone will readily agree with Mr. Littlehailes in this respect, should concentrate on the humanities and leave technological studies severely alone, for it is of the regional type and the environment most suited for enhancing its sphere of usefulness, is philosophy, ethnography, anthropology, literature and fine arts, and not industry, commerce and technology.

There are one or two paragraphs in this otherwise able address which contain controversial subjects on which Mr. Littlehailes' opinions are likely to be called into question. According to him, the test of our ideal is how far it squares with the material facts of life and in his opinion India's greatest need is not the solution of unemployment problem nor a change in the industrial position, but the greatest need is to materialize the ideal testing it against the facts of life. In no part of the address could we discover him stating what this ideal is or ought to be and he has not specified the material facts of Indian life against which he calls upon the graduates to test the unnamed ideal. If by ideal we mean a mental concept of a standard of perfection which the mind continually yearns to attain but seldom reaches, clearly its test is not to square it with the material facts of life, for if you do, it must necessarily partake the character of practical expediency. The basis of an ideal is the innate craving of life to reach an unattainable excellence and in its efforts towards this end, modifies the material facts of life to be helpful for its progress and will ignore them if they are unalterable. But this is the first time we hear of the exalting of the material facts of life to which the ideal is to conform its scope and ambition. But what are the facts of Indian life?

1. Famine, poverty and malaria.
2. Over-population, unemployment and ignorance.
3. Political subordination, lack of initiative and helplessness.
4. Intercommunal jealousies, agitation and ordinance.
5. Social injustice and economic depression.
6. Good government, peace and order and progress of education and diffusion of Western sciences.
7. Great engineering works, cheap and rapid transportation, posts and telegraphs.
8. Improved methods of agriculture, rural sanitation and heavy taxation.

Is there any ideal on the part of any living individual which can be made to square with these facts? Even the exponent of this somewhat startling new theory may not discover one. Evidently there is a confusion of ideas. What Mr. Littlehailes probably means is the guiding principle of life, something in the nature of a motto which we distinguish from an ideal,

His conception of the aim of the University embraces a few possible and a larger number of impossible things and if any University were to set out to achieve some at any rate of these, it is bound to land in disappointment. "To research, to teach, to add to the stock of knowledge of the world, to wisely impart to its students some of the existing knowledge, to form the character of its students, to educate them to acquire a critical spirit, a balanced judgment and an independence of intellectual thought, to produce an attitude of mind which places the possessor on a different plane from that of his fellow and to so train its students as to enable them suitably to take up some profession and occupation in life." These infinitives will either provoke the smile or break the heart of the University Professors. The true function of the University is to provide in their professors and laboratory equipment, men and material which the students are invited to utilize to the top of their intellectual and moral bent and they can no more produce "character" in the alumni than they can transmute metals. The trouble with most men is that they are unable to realize adequately that the students' mind is a kaleidoscope, the pattern and colours of which are traceable to remote ancestry and any change in them must come from self-exertion and initiative on his own part. The University provides the most favourable environment for this self-expression which is true education. Any change imposed from outside can be neither valuable nor permanent. An exposition of the aims of the University such as Mr. Littlehailes has attempted, is apt to mislead the public to expect the impossible from the University teachers who will be held responsible, on the basis of this theory, to produce gold even if they are given pewter. They can only help the material to polish itself.

In spite of these somewhat debatable points, Mr. Littlehailes' address is a readable document containing much useful information. A. N. R.

Science News.

MESSRS. C. REICHERT of Vienna, have now placed in the market a new outfit for fluorescence microscopy (list No. 6065*e*) designed by Haitinger. The source of ultra-violet rays is an electric arc between two metal electrodes which, while providing an intense light, consume but a very low current. Several new features are incorporated in the outfit which enable its use for fluorescence photomicrography, as also for fluorescence spectroscopy and spectrography. The obvious advantages of fluorescence microscopy promise a great future for this branch of microscopic research and the firm of Reichert who are pioneers in the construction of fluorescence microscopes have now added a very useful instrument to research workers in this line.

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We have received a copy of a pamphlet published recently by the Society of Biological Chemists (India), wherein is summarised the proceedings of the Symposium on "The Role of Organic Matter in Soil" held under the auspices of the Society on 30th July 1932. A report of the Symposium has already been published in the August number of *Current Science*. The present pamphlet gives more detailed abstracts of the papers presented at the Symposium and includes a full report of the discussion that ensued. This useful brochure will be read with great interest by all those working in the various branches of this important subject.

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The beautifully printed and illustrated handbook *German Universities—A Manual for Foreign Scholars and Students* (published by the Deutscher Akademischer Austauschdienst E. V., Berlin C2, Schloss) gives a general account of the main features of the organization and character of the German Universities, the various aspects of German social and scientific life in the important University towns, to all who may intend to study in any of the German Universities. The publication is issued by the German Academic Exchange Service whose main object is to secure and foster cultural contacts with foreign countries. At present it is to be regretted that this exchange service maintains no working relations with any organization in India and it is hoped that the matter will soon engage the attention of the Indian Inter-University Board. The aim of the German Universities is well worth reproducing in the language of the statutes adopted by them.

"It is the task of the University to promote knowledge by research and instruction. In pursuance of this it must never lose contact with the vital forces of the country of which it is a part. It must prepare students for entrance into the various branches of higher state and public services, as well as for other professions which require a University training. As a community of teachers and students, united in the spirit of truth, it seeks to develop the normal character of the students and to educate them to responsible membership and collaboration in society, to the end that the national and cultural welfare of the people as a whole may be served."

This ideal is attempted to be reached by an academic freedom in teaching and learning and under its influence the student "is compelled to discipline himself and to acquire these principles of independent and responsible action that will guide him," in his University and extra-mural life.

The manual gives complete information regarding the types of Universities and institutions of higher learning, their administration, admission of students into them, the courses of studies and facilities of research offered by them, the tutorial methods and system of examination, the cost of study and living, excursions and social amenities, scholarships, descriptive accounts of university towns and other matters of special interest for foreign students.

It seems very desirable and even urgent that India through some central organization enter into working relations with the German Academic Exchange Service and other similar institutions in Europe and America and make known to students and others who may plan to study or

to travel in these countries, the facilities offered by them. If these service organizations could find the means for promoting and consolidating the intellectual sympathy and better understanding among the young men of different countries and abolish the mistrust and ignorance which separate them, then the cause of World Peace will be on the high road of accomplishment.

B. R. S.

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Rao Bahadur Professor B. Venkatesachar, M.A., F.Inst.P., has been invited by the Annamalai University to deliver a course of five lectures on "Atomic Nucleus and Hyperfine Structure of Spectral Lines". These lectures which are intended mainly for Honours Students will come off on Monday, the 6th February 1933 and terminate on Friday, the 10th February 1933 commencing each day at 5 P.M.

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Under the joint auspices of the Society of Biological Chemists (India), Bangalore, the Association of Economic Biologists, Coimbatore, and the Madras Branch of the Indian Chemical Society, a three-day meeting was held at Coimbatore on the 7th, 8th and 9th October. The Conference began on the 7th with a Symposium on "Utilization of Waste Products" presided over by S. V. Ramamurthy, Esq., I.C.S., Director of Agriculture, Madras. The following papers were read and discussed :—

"Sewage and Domestic Wastes." By Dr. Gilbert J. Fowler.

"Utilization of Farm Wastes." By Mr. K. S. Viswanadha Iyer.

"Utilization of Waste Vegetation." By Dr. V. Subrahmanyan.

"Waste Products of Paddy and Sugarcane Crops." By Rao Bahadur B. Viswanath.

"Waste Products of Dairy." By Mr. T. Lakshman Rao.

"Some Industrial Wastes." By Mr. M. Sreenivasaya.

On the 8th Mr. M. Sreenivasaya delivered an address on the "Present Status of the Problem of the Spike Disease of Sandal".

An interesting discussion followed which was continued on the 9th and which clearly proved that Spike was a disease due to some infective principle and not a physiological condition of the plant.

In the afternoon of the same day several original papers were read under the presidency of Dr. Fowler.

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We acknowledge with thanks the receipt of the following :-

"The Indian Forester," Vol. 58, No. 10, October 1932.

"Chemical Age," Vol. 27, Nos. 690–693.

"Brooklyn Botanic Garden Record," Vol. 31, Nos. 1–4.

"British Association for the Advancement of Science—York Meeting," July 1932. Addresses, Journal and Transactions.

"Archiv Für Zoologie," Heft 23, Nos. 1–4.

"Bulletin of the Madras Government Museum," Vol. 1, Part 2.

"Transactions of the Mining and Geological Institute of India," July and September 1932.

"Nature," Vol. 130, No. 3284.

"Canadian Journal of Research," July 1932.

"Natural History," Vol. 32, No. 5.

"Journal of Urusvati Himalayan Research Institute," Vol. II.

Reviews.

MAXWELLIAN OPTICS, *Theory of Light*. By Professor Max Planck, translated by Prof. H. L. Brose. (MacMillan & Co., 1932, 8 vo. pp. 213.) Price 10*s*. 6*d*.

In the volume under review, which is a translation from the original German, Prof. Planck has given a very clear, compact and comprehensive treatment of "Classical" optics from the standpoint of Maxwell's theory of electromagnetic wave-propagation. In the concluding chapter, the connections between classical optics and quantum mechanics are set out. It is obvious to any one who has been a teacher of the subject that there is a great gain in treating physical optics from such a unitary point of view. The following though of a coherent train of thought is the essence of a good course of lectures, and, it may be added, also of a good book. The serious student who desires to obtain a grasp of optical principles without wasting time on details of minor importance must feel grateful for having such a volume as this put into his hands. The mathematical apparatus employed is comparatively elementary and is such as should be well within the capacity of B.Sc. (Hons.) and M.Sc. students of Indian Universities to understand.

The fact that the present book is the fourth of a series of five volumes by its distinguished author suggests certain reflections on the subject of the teaching of physics in Indian Universities which may not inappropriately find a place here. The astonishing rate of development of physics of recent years has made the adequate teaching of the subject a task of peculiar difficulty. It is quite natural and appropriate that much attention should be paid to the study of "modern developments" and that the more promising students should exhibit enthusiasm for taking up "research" as part of their syllabus of study. At the same time, it should be remembered that an edifice of ill-digested knowledge erected

on an insufficient foundation of preparatory study is worse than useless. A broad-based knowledge of mechanics, thermodynamics and electromagnetism with an adequate mathematical discipline such as is furnished by the published lectures of Prof. Planck should be compulsory for every advanced student of Physics. Only on such a foundation of knowledge, can the study of modern developments and the participation in research possess any real educational and intellectual value.

SIR C. V. RAMAN.

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Annelida Polychaeta of the Indian Museum, Calcutta.

A monograph on the Polychaete worms of the Indian Museum collection by Prof. Pierre Fauvel, the distinguished French specialist which has recently been published in Vol. XII of the *Memoirs of the Indian Museum,* deserves special mention. Though primarily a systematic account of the collections in the Indian Museum, the work is really the first monographic attempt of the Indian species of this very difficult group of marine worms. The author has published in this work detailed synoptic keys of the families, genera and species of almost all the Indian Polychaetes and thus made it possible for future workers to identify their material, to some extent, without having to search through the very scattered and extensive literature on the subject. Some of the outstanding general conclusions of the work to which attention may specially be directed are as follows:—The Polychaete fauna of Indian waters does not materially differ from that of the Red Sea, the Persian Gulf, the Malay Peninsula and the Philippines, but many forms which are known in New Zealand, New Caledonia and Australia are also found in these waters. As a result of critical studies of the Indian material, 67 of the Indian species have been found to be identical with forms found in the Atlantic Ocean, English Channel and the Mediterranean. The coastal fauna, as might be expected, is generally richer in species than the deep-sea fauna where the biological conditions are much less variable and the animals are less influenced by extraneous factors such as influence the life in the inshore waters. The forms recorded and described from the brackish water areas, such as the Chilka Lake, the Cochin Backwaters and the Gangetic Delta, were found to be specially modified and peculiar. A further factor of interest about these forms was that identical species were found in collections from the Indian brackish water areas and the Taléh-Sap or the Inland Sea of Singgora, a brackish water lake connected with the Gulf of Siam.

B. P.

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The Practice of Absorption Spectrophotometry. By F. Twyman, F.Inst.P., F.R.S. (with the collaboration of the staff and advisers of Adam Hilger, Ltd.) (Adam Hilger Ltd., London.)

The subject of "Absorption Spectrophotometry" is of late finding such high favour among an increasing army of scientific workers—Bio-chemists in particular—that Messrs. Adam Hilger, Ltd., have, by publishing this useful little volume, earned the gratitude of many workers in this field. The first five chapters have been written in a lucid style by F. Twyman, F.R.S. and deal with the nature and laws of absorption, the apparatus and technique of absorption spectrography in the ultra-violet, visible and infra-red regions, and the application of Photo-electric methods to Spectrophotometry. Detailed instructions regarding the use of the Hilger instruments, their adjustment and alignment, selection of exposures, taking and recording of results, etc., are also carefully given that an adherence to the instructions given is bound to be valuable in this line of investigation.

The staff and advisers of Messrs. Adam Hilger, Ltd., have contributed the following three chapters in which are outlined the salient features of "Absorption Spectra and Molecular Constitution", "Biological Applications of Spectrophotometry" and "The Detection and Investigation of Poisons and the Control of Purity in Foodstuffs". A review of the present knowledge on absorption spectrophotometry as related to Vitamin D and allied topics is contained in section (*b*) of the chapter dealing with Biological Applications and should be able to convert a large number of vitamin specialists to the adoption of spectrophotometric methods in their work. A brief outline of emission spectrography as applied to the study of the above problems forms the subject-matter of appendix A, while in appendix B is given a short and general outline of the Raman Effect.

P. S.

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Recent Applications of Absorption Spectrophotometry. (Adam Hilger, Ltd., London.)

This is an extensive collection of Bibliographical references to the subject of absorption spectrophotometry and serves as a companion volume to the previous book. It is needless to stress the usefulness of such a list of references.

P. S.

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Indian Caste Customs. By L. S. S. O'Malley (University Press, Cambridge, pp. ix+190. 6*s*. net.)

The present volume on the fascinating subject of "Indian Caste Customs" contains nine chapters, each of which is devoted to a special topic on caste. Leaving the endless discussions on the origin and evolution of caste to the arm-chair philosophers of Europe, the author gives in the first four chapters a brief summary of the caste system, caste government, its controls and penalties.

Hindu society is divided into a number of divisions known as castes which are graded in order of social precedence and each caste again is divided into a number of sub-castes. To a student of Social Anthropology the modes and formations of castes and sub-castes which are taking place all over India are of peculiar interest.

The caste system is least precise on the northern borders of the Indian Empire, in Assam, the Panjab, the North-West Frontier Provinces, Kashmir, Sind and Nepal and very strict in South India. Regarding the caste government the author mentions the salient features of the old Panchayat system assisted by the elderly members. The lower castes are much better organized than the higher ones whose machinery for the regulations of their affairs have already become lax. Ordinarily it deals with all questions arising within its jurisdiction and its permanence and authority do much to promote the solidarity of the castes and to preserve the discipline among its members. But for grave and important matters, it gives place to a general assembly of male members of the caste. Even then the members of the council guide the discussions and have a large voice in the final decision. On grave offences of caste the rulers of the Indian States are the final authorities. There is a regular code of punishments for the delinquents which are graded according to the gravity of the offences. The next four chapters deal with the marriage, morals, food and drink, occupation and the untouchability. It is sometimes said that the caste institution exists more for its regulation and maintenance of marriage customs and for preservation of chastity. Marriage must take place within the caste or sub-caste. A girl may be married within her caste and must be among members who are not related but never below. Here the elaborate rules of prohibition are in force to prevent marital relations among those who are closely related. Any violation of these rules will result in expulsion from caste. Thus caste preserves chastity in women. Equally important are the rules connected with food and drink about which the caste men are very particular. To a large extent occupation is the basis of caste and under modern industrialism based on mechanical inventions, traditional occupations of caste are declining and the caste men either relinquish their traditional occupation in favour of more lucrative ones or take to another to supplement their income. Regarding the untouchables it is curious to note that they constitute a well-defined distinct caste with sub-divisions of its own. Its peculiar usages and traditions as also its own jealousy of the encroachment of the castes which are above and below it. They are equally with the higher castes filled with that compound of pride of birth, exclusiveness and jealousy called "caste feelings". Regarding the caste organization of India there are scholars who condemn it as "the most disastrous and blighting of all human institutions", and one has described it as "a gigantic system of cold-blooded repression", while others have opined that caste has been useful in promoting self-sacrifice, in securing subordination of these individuals to an organized body, in restraining from vice, and in preventing pauperism. It must be said that caste has been a marvellous discovery, a form of socialism which through ages has protected Hindu society from anarchy and from the worst evil of industrial and competitive life.

Mr. O'Malley has to be congratulated on the production of an interesting volume which all students of Social Anthropology and the layman will much appreciate.

L. K. A.

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Disarmament.

JUDGING from press notes and preliminary talks of the ministers, we infer that as soon as Germany is induced to join the other Powers, the more serious discussions about disarmament in the Bureau of the Geneva Conference will relate to the limitations and certain alterations in the character of the implements of war. One may reasonably doubt whether these proposals alone have the power in themselves to mitigate the horrors of hostilities, if, unfortunately, in spite of the best endeavours to the contrary, they should break out. Will men become so civilized and spiritually perfected as to employ love and self-sacrifice instead of hatred and destruction in the settlement of all international differences? This is by no means an idle and fantastic proposition, but at bottom a biological question and on the answer we give to it must depend the prospect of the future of our race. It is obvious that scientific ingenuity will make up for restriction in the number of weapons, their change of calibre, the reduction in the tonnage of fighting vessels and aeroplanes, by the intensity, range and rapidity of their powers of annihilation. Let us not make the mistake of deluding ourselves into the belief that the sense of war-weariness which has overtaken Europe since 1919 is synonymous with a reformed mind yearning for peace and goodwill. These are no doubt the very things for which we labour, but the road we are treading may not possibly lead to them. Even a purely material civilization need not necessarily be hostile to the existence of spirituality among the people without which universal peace, amity and concord in human relations and affairs can only be conventional.

The progress of civilization has nearly succeeded in replacing the dispensation which enjoins us to love our enemies, to bless them that curse us, to do good to them that hate us and to pray for those who despitefully use us and persecute us by the Gospel of international loaves and fishes. We are familiar with the public pronouncements of politicians at the time of the Great War that the only justification of their entering it was the vindication of the honour of international pacts and treaties and the protection of civilization which the conflict had threatened to submerge. Speaking in the House of Commons in 1923, Mr. Baldwin referred to

this civilization thus, "I have often thought, with reference to the late war that one of the most terrible effects of it,—possibly a double effect—has been that it has shown the whole world how thin is the crust of civilization on which this generation is walking." It is quite obvious that a machine civilization with its concomitants, overproduction, unemployment, swollen population, economic competition, bitter vicissitudes of public credit, must inevitably lead to frequent disputes and occasional open hostilities. The scientific discoveries and the inventions of the nineteenth century which formed the basis of the industrial revolution,—perhaps the most impressive phenomenon of modern times,—were welcomed in the hope of their exerting a great humanizing influence on man, but the war demonstrated that primitive barbarism was only latent and could be roused into perfect savagery at the first blast of the trumpet. In the pursuit of discoveries, we stuck fast to the laboratory and forgot the Ten Commandments and these scientific achievements while they tended to improve the material comforts and life-saving devices on the one hand also helped on the other to perfect the means of destroying life. It is true that we have made great strides in our knowledge of the secrets of nature, and in a great measure we have harnessed her forces for the service of man, but his moral evolution has not kept pace with the progress of industrialism and we are now paying the penalty for not keeping the equipoise between the advancement of spirituality and that of machinery. The main criticism against our civilization by the artistic disciples of Ruskin and Morris is its tendency to standardise everything including our public taste and the working of the mind and to interpret nationalism in terms of natural laws without reference to those Evangelical doctrines which promised the blessings of peace. It is just as futile to endeavour to cure the acquisitive spirit of man by limiting the opportunities of competitive ambition as to eliminate his fighting instincts by imposing restrictions on the weapons of warfare.

The darkest hour in the history of our civilization was reached in 1917 and in 1919 a great opportunity occurred when through a determined co-operative effort of all the nations, the course of the whole civilization might have been deflected into a new channel promising peace and goodwill. There were two courses open to the Powers to strike a new path, not by any means chimerical, but only demanding the will to see and to sacrifice. The victorious allies, had they extended the hand of fellowship to the beaten enemies and had said that they would forget all the happenings of War, provided that the expenditure on armaments were given up on both sides, would have placed human progress on a new and different plane. But knowing human nature to be what it is, this is clearly an impossible and impracticable suggestion. We may be civilized to the point of wearisomeness in the language of Kant, but our minds are not sufficiently spiritualized to rise to the apocalyptic heights from which visions of a new world are to be seen, visions of a new race of mankind and a new order of things which such a Christian course might have produced. Perhaps the second procedure which is less extravagant but equally difficult to pursue might have been considered practical, and, had it been adopted, the world would not have had to pass through the post-war travails to which she is subject to-day. The problems of reparation, war debts, disarmament and economic rehabilitation of Europe might have been referred to a Commission composed of a humanist, a financier and an engineer belonging to the neutral Powers in whose integrity and judgment the belligerents might have had unbounded confidence and by whose decisions they would have unhesitatingly abided. The expenditure of the Commission could have been defrayed by the allies and the enemies jointly and till the submission of the report of these experts, the Powers might have agreed to suspend all their activities of repairing and strengthening their armaments and to resume their normal pre-war economic relations. The Commission would have been instructed to submit their report fifteen years after the date of their appointment, a period of time in which our feelings of anger and vindictiveness and our memory of the atrocities perpetrated during the progress of the War, may have been softened or partially forgotten so that the Powers would have been in a fit position to examine the findings of the Committee with some measure of calm and collected mind in a peaceful atmosphere. Having in the meantime built up their economic and financial resources at least to some extent, the belligerent nations would have been in a position to

bear and fulfil their respective financial obligations. Psychologically it is uncharitable to expect the victorious allies smarting under a sense of grievous wrongs, to deliberate at Versailles immediately after the War in a dispassionate and Christian spirit all the problems arising out of the stupendous conflict in which the geographical boundaries were torn and in which there was reckless waste of men and money. It was in 1919 that civilization and religion deserted the nations and we were too blinded by the animal passions to read the teachings of both, and unconsciously affirmed the doctrine of Dean Inge that human progress is not vertical but moves in a vicious circle. But better things might have occurred and it is tempting to dream of a new world, in which reason, conciliation and love will be the ruling factors of the life of mankind.

The problems of disarmament, war-debts and reparations form the three strands of the international skein and the Powers find it difficult to discuss any one of them without reference to the other two. They have their roots deep in the social and political structure of Europe and their satisfactory solution must necessarily involve a more searching examination of this tangled fabric. The chief object of "notes" and "consultations" about the first two questions is the insistence of the United States on the stoppage of expenditure on armaments on the part of her debtors and the demand that the amount should be devoted to the payment of their dues. The plea of the European Powers is that on account of the distracted state of their finance and trade they desire the postponement of the payment of their debts so as to enable them to discuss further possibilities of arranging for payments more satisfactorily to themselves. Britain has cancelled sixty per cent of the dues which her debtors owe to her and she has to pay nearly 200 millions more than her allies. France has renounced her claims on German reparations and having to devote the greater part of her revenues for renovating her industries, pleads inability to meet the demands made on her. America complains that in order to maintain her armament level with the European Powers she has to spend without receiving her dues. All the countries suffer from economic and financial depression besides having to face the problem of unemployment on an unprecedented scale. It seems to us that the way out of this tangle is that the European Powers should declare that they would suspend further expenditure on armaments for the next fifteen years and divert the funds thus released for the purpose of rebuilding their disordered trade and broken finance and for social reconstruction and ask for a moratorium for this period. At the end of this period when trade and finances have improved, the issues of war-debts can be discussed in a more favourable atmosphere and with greater chances of a satisfactory settlement. A courageous policy such as this is sure to appeal to the better mind of the Americans who still pray daily, 'Forgive us our debts, as we forgive our debtors' as an evidence of a genuine desire on the part of the European nations to set their houses in order and to establish peaceful settlement, making due provision in the meantime to meet their obligations to the fullest extent. It is inconceivable that when the whole spinal system of Europe is paralysed, any one nation will, during this period, become truculent or aggressive and were it to show such symptoms all the other nations with one common will should exert a complete economic blockade on the offending Power and this, more than an appeal to arms, is calculated to bring it to reason. Such a warlike nation should be made to forfeit automatically the benefits of grace.

The problem of disarmament as we envisage it, is wider than a mere question of restriction and it should include in its programme the exploration of the possibilities of ultimately establishing permanent universal peace. Other instruments than war should be discovered for the settlement of economic or racial differences if such should arise at all. . We do not believe that war is necessary to comb out the unfit from among us or to solve the problem of unemployment and to raise the national efficiency for which we have to seek the assistance of the infant science eugenics. We are aware that immediate and complete abolition of armaments though necessary in the interests of wider humanity may not be a practical suggestion but that it should be the final objective for the preservation and progress of our race, we are convinced. If the governments of the five Powers should for any reasons fail to achieve this supremely desirable end, perhaps it will be the task of the people sooner or later to enforce it. In discussing the various plans made by the European and American governments for assisting the progress of disarmament and peace, the ministers will, it is hoped, bear in

mind Mr. Baldwin's grave warning recently given about the terrors of aerial war. The man in the street ought to realize thoroughly the devastating powers of the gas and disease bombs with which a couple of aeroplanes may utterly annihilate the civil inhabitants of a populous city so that in aerial warfare both the belligerents are in grim danger of total extinction. If our civilization cannot dispense with armaments for the purpose of maintaining international concord or for the purpose of protection from foreign aggression, the only alternative is to embark on the policy of increasing and perfecting our lethal weapons in the vain hope that neighbours who live in *terrible dread* of each other's powers of destruction may live in peace because either is afraid to infringe it for fear of disastrous consequences. We would then be having a balance of peace such as is preserved among the fierce animals whose best protection is their savage ferocity and those endowed with neither strength nor courage will have recourse to various adaptive modifications to escape subjugation or total slaughter. The teachings of religion, the ideals of progress and the very foundations of our social organization must refute the suggestion that we cannot, with a supreme effort of co-ordinate determination on the part of all the civilized races of mankind, discover and devise methods of settling our disputes in a more humane manner than by clash of arms and that we cannot live in mutual sympathy and love without the necessity of armament as an instrument of peace. So long as the tiger in man is not replaced by a spirit of true Christian meekness we remain in usurpation of the earth and not in legitimate inheritance.

The essence of modern civilization is the subordination of religious values to economism and its outward expression is that while it preserves the fighting instincts of man it blunts the keenness of his praying faculty. Our present economic relations are so delicate and complex that the violation of any one of their laws must inevitably invoke the aid of armaments for the restoration of the disturbed balance,—a process which always worsens the old situation. "It is not certain that there has been much change in our intellectual and moral endowments since Pithecanthropus dropped the first half of his name." The reason for this accusation of our progress is that current schemes aim at reforming and improving the social organization as a whole, neglecting the individuals who compose it and the task of perfecting the individuals now becomes the province of science, especially of the biological science of eugenics. Perhaps a scientific civilization which, it is hoped, will secure "the passage of a less desirable state of life to a more desirable", may succeed in producing an international mind setting up qualitative values for checking our estimates of good or evil in the social, economic, political and cultural relations. In the meantime the greatest need is a vivid and sincere recognition of the fact that the spirit of militarism, still haunting the public mind of Europe should not be permitted any longer to vitiate even unconsciously the noblest efforts of her ministers to establish mutual concord and trustfulness on a basis of a real and permanent international partnership and to secure and fortify the national rights by the purity and elevation of a stern public opinion. Mr. Baldwin once said that there are "four words of one syllable, each of which contains the salvation of this country and of the whole world and they are 'Faith', 'Hope', 'Love' and 'Work'." It may sound almost like a Utopian idea to suggest the substitution of these monosyllabic words as instruments of international negotiations for the establishment of peace more than "Disarmament", "Reparations" and "War Indemnities". This idea, though it may not be realized in the near future, should not be permitted to remain long beyond the range and grasp of Christian temper and collective statesmanship.

Marine Biological Research in India.

By Lt.-Col. R. B. Seymour-Sewell, M.A., SC.D., F.Z.S., F.A.S.B., I.M.S.,
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THE outstanding fact about India is the poverty of the people and the prospect this becoming steadily worse with the ormous growth of the population until, iling wars or pestilence, starvation itself eps in to adjust the balance. No one is ·ing anything about this." So writes Mr. 'thur Moore in his article on "Beloved dia" in the *Fortnightly Review* of October st; and he goes on to add that "it ought be possible to devise a great Indian plan ...to organize her (India's) agriculture d her other industries, so that her people all get the benefit in good wages and higher standard of living and increased nsumption of her own products."

To anyone who has had any experience of dian fisheries and who has been able to mpare the conditions that exist in India th those that pertain in almost every other rt of the world, it is abundantly clear that e marine resources of India are at the esent time almost untouched and that an nost inexhaustible supply of cheap and holesome food, as well as of other marine oducts that form the basis of trades, such button making, etc., remains for the most rt unexplored and unexploited. The occu- tions of fishing or dealing with fish is garded throughout India as one to be car- d on only by low caste people and as a sult the entire fisheries are left in the hands those who are not in a position, either ellectually or financially, to develop em, while in every main centre the actual arketing of these supplies has become ncentrated in a close "ring", part of ose system is to see that the actual fisher- n are kept in a continued state of debt on count of funds advanced to them by the mbers of this "ring" for the purchase of ar, etc., and who frustrate any attempt to rease the supply of fish by a refusal to rchase the catches made by any organiza- n that is not under their immediate ntrol. From time to time abortive experi- nts in marine fishery work have been rried out by certain Provincial Govern- nts, such as the investigations of the ngal Marine Fisheries by the "Golden own" in 1908-09 and those of the Bombay ast by the "William Carrick" in 1921-22, and in each case the conclusion reached was that there is an ample supply of fish in Indian waters that could be caught by such trawling methods but that to be a com- mercial success much greater facilities for the distribution and sale of the catches would be necessary. As Dr. Amirthalingam has pointed out in his letter to *Current Science* (Nov. 1932) it by no means follows that the methods of catching fish that are at the present day employed in European waters will prove to be most suitable or suc- cessful in Indian Seas, and one line of re- search that is much needed is the scientific investigation of those methods that have been employed in tropical waters in other parts of the world, especially those in use among the Japanese and Chinese fishermen.

Such investigations clearly cannot be under- taken by the fishermen themselves and although it may be possible in the future to educate the members of the fish "rings" in the large ports of India sufficiently to enable them to recognize that improved fishing methods will lead to increased markets and, therefore, to increased profits, and thus to enlist their financial support for such marine investigations, as has been done in England and other countries, it is clear that in the main one must look to Government aid for these purposes. Unfortunately at the present time the Governments, both Provin- cial and Imperial, appear to be far more interested in Agriculture than in Fisheries and, although in the past these two subjects have been administered by the same depart- ment, so little attention has been paid to the latter that, with the single exception of Madras, there is not a single province with a Fishery Department worthy of the name. Indeed, in certain provinces there has been a very retrograde movement, as, for example, in Bengal, where in 1915 there was a Fishery Department of Bengal, Bihar and Orissa employing a Deputy Director, two Superin- tendents and one Assistant, whereas there is at the present only a single Fishery Officer; and other provinces appear to be in like case.

If ever the Fisheries are to be improved and placed on a proper basis, it is clear that scientific research on both the fauna itself

and the conditions under which the fauna is living is the first essential. In 1920 a Committee was appointed by the British Association for the Advancement of Science to consider the question of Marine Biological Research in India and they reached the conclusion that it was only by the erection of a Marine Biological Station that any considerable improvement in our knowledge could be made, while at the same time they drew attention to the need of providing increased facilities for the biological work of the Surgeon-Naturalist on board the R.I.M.S. "Investigator". As regards this latter recommendation it may be pointed out that, far from increased facilities being granted, on the transfer of Lieut.-Colonel (then Major) R. B. Seymour-Sewell, I.M.S., from this post to that of Director of the Zoological Survey of India, the post of Surgeon-Naturalist was held by Major R. W. G. Hingston, I.M.S., during one survey season, from October 1925 to April 1926, after which he proceeded on leave and later retired from the service and no scientist has ever since been appointed to succeed him. There has, therefore, been a complete cessation of this branch of study, and indeed at one time there was considerable danger of the post itself being actually abolished by the Government, who appeared to be under the impression that the work of the Surgeon-Naturalist was of neither actual nor potential value. As no suitable scientist could, under present conditions, be provided by the Indian Medical Service, the Secretary of State agreed to the post being transferred to the Zoological Survey of India but so far no officer has been appointed, nor is there any likelihood that one will be appointed in the near future owing to financial difficulties. Thus this line of scientific marine research has come to an end at any rate for the time being.

In 1920 a detailed scheme for the erection of a Marine Biological Station was submitted to the Government of India by Dr. S. W. Kemp, who was then the Superintendent of the Zoological Survey of India and who had been deputed by the Secretary of State to investigate the Marine Biological Stations of Europe during a period of his leave. A similar proposal for the erection of a Marine Biological Station under the Madras Fishery Department was put forward in the following year by Mr. Whitehouse, of the Central Training College, Lahore. Dr. Kemp's proposal was for the erection of a station in Port Blair in the Andaman Islands, where the fauna is known to be particularly ric and where, owing to the geographic position of the islands, oceanic condition are present; but in 1926 the proposed site c this station was changed to Karachi, as i was felt that Port Blair was too inaccessibl and that Karachi would offer a mor accessible site to which advanced student from all the Universities of Northern Indi could easily come and where, further, th scientific staff of the station would be i close touch with fishery work and commer cial fishing. Although at one time i appeared possible that the Governmen would erect this station and full plans wer drawn up and a suitable site allocated their actual sanction was postponed yea after year until the present financial positio of the Government renders its fulfilmen beyond the bounds of hope.

It is, therefore, with all the greate satisfaction that one welcomes the suggestio made by Dr. S. B. Setna that a Marin Biological Station should be erected i Bombay; and one sincerely hopes that h will be enabled to raise sufficient funds fron among the far-sighted inhabitants of th city. The work of such a station falls int two categories, namely, the purely scientific and educational side, and the economic aspect; and of these the first is, at any rate at the outset, by far the more important, since no real improvement of the fisheries themselves can be made without a scientific basis and the data required for such a basis may take several years to obtain, especially in such a country as India, where the number of trained zoologists is comparatively small and where there are such marked differences in the conditions under which the fauna is living along the extended coast line of the Indian Peninsula. As has been pointed out by Kofoid in his *Handbook to the Biological Stations of Europe*, the great research stations of that continent "are supported largely and often almost exclusively (except in Great Britain) by State and local funds. This is made possible in European countries by the recognition on the part of the State of the relation of research to higher education in biological sciences." One of the main questions that must be faced if a Marine Biological Station is to be established is the provision of funds for its upkeep, when it has actually been established; for it is clear that it would be perfectly useless to go to the expense of building such a station, if in a year or two

it would have to be closed down for lack of financial support. In the selection of an appropriate site for such a station one must of necessity take this factor into consideration, as well as others such as the abundance and variety of the local fauna and flora, the ease of access, the varied types of environment, the tidal amplitude, climatic conditions and, last but by no means the least, the purity and salinity of the water; and this last consideration will present very considerable difficulty in such a port as Bombay. On the other hand, it is only in such a centre, where there is a large and well-educated public and where in this instance there is the added advantage of having in the city such a well-known and widely influential scientific society as the Bombay Natural History Society, that there would be any probability of being able to raise sufficient support locally to ensure the maintenance of the station. Should the station be started, there is little doubt that many of the Universities would contribute towards its upkeep in the same manner as is done in Europe and other countries by renting "tables", to which advanced students can be appointed for the purpose of carrying on research; other lines along which additional funds may be obtainable are by the supply of material to colleges for the practical instruction of classes within the Universities themselves, but in this case the new station will have as a rival the already established branch of the Madras Fishery Department, that now supplies most of the wants of the Indian Colleges. Finally there will doubtless be a large number of visitors, both educated and uneducated, the latter especially during the pilgrim season, who will pay to come and see the Aquarium, that must necessarily form a part of such a station; but in this connection it must be remembered that the admission fee must be kept as small as possible or many of the poorer people will not be able to afford it. From a careful consideration of the whole matter it seems that only one conclusion regarding the financial outlook is possible and that is that such a station cannot, at any rate at first, be self-supporting and it is doubtful whether it would ever be, even after it had succeeded in proving beneficial to the fisheries of India and, therefore, might naturally expect to obtain some financial support from those who in the future will be exploiting the fisheries of India for their own private or public profit.

Sewage Farming in India.

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ALTHOUGH a considerable amount of highly valuable research has been carried out on land disposal of sewage, yet the available scientific information with regard to the utilization of sewage in agricultural practice is comparatively limited. As the result of this and the general impression that the problems connected with sewage belong to the domain of sanitary science, we find hardly any mention of sewage farming in books on agriculture. On the other hand, utilization of sewage or sullage, as the case may be, plays a very large part in agricultural practice, particularly in the Far East, and, in view of the valuable fertilizing ingredients present in it, deserves to be even more widely adopted than in the past. It is no doubt true that popular sentiment has generally been against the use of sewage, but there is, as yet, no sound scientific evidence to support such an impression: in fact, the remarkable success achieved on certain experimental farms and by several private individuals, particularly market gardeners, would clearly indicate that, with judicious handling, sewage would be the cheapest and, at the same time, one of the best fertilizers used by man. In this direction much valuable information is available from the reports of some of the sewage farms in India and the object of the present contribution is to present a brief account thereof and to draw attention to certain lines along which further scientific work has to be carried out to place sewage farming on sound, economic and, at the same time, hygienic basis.

There are several sewage farms in India and some of them are very old, dating back to the middle of last century. Unfortunately, most of them do not either possess proper records or have not been carefully maintained, so that the considerable amount of what might have been valuable information,

is now lost. Although most of the farms referred to in the present paper were started within the past two decades, they yet possess the advantage of having been run along scientific lines, so that the information provided by them would be of great practical importance.

The effluent farm near Poona was started in 1918 and now covers an area of over 63 acres. The effluent is derived from septic tanks and used for irrigation after suitable dilution with canal water so as to provide about 300 lbs. of nitrogen per acre, in the course of one year. Among the experiments carried out on that farm may be mentioned: (*a*) effect of quantity of nitrogen applied as effluent on the out-turn of sugarcane, (*b*) comparison of sewage effluent with other fertilizers, (*c*) response of different varieties of cane to irrigation with effluent, (*d*) effects of season, frequency of watering, and rotation with other crops on yield and quality of cane, and (*e*) response of various market garden crops, fruit trees, betel vine, etc., to sewage irrigation. The observations which are spread over several years show that, by judicious irrigation with the effluent, very heavy yields of cane, often amounting to double that obtained by water irrigation can be obtained. It is profitable to reduce the depth of water from 140″ as generally used by the ryot to 80″. Except in shallow soils the best results are obtained by watering at 10-day intervals. Sugarcane will not ripen unless the effluent is withheld for three months before harvest, so that, when irrigating sugarcane, it would be necessary to run duplicatory channels with water. Application of even concentrated doses of effluent does not have any appreciable effect on the soil or on most of the crops that were tried. Sugarcane responds to increasing dosage of nitrogen up to a maximum of about 300 lbs. per acre. The effluent is in no way inferior to the other manures commonly used for sugarcane. Legumes are the best rotation crops for sugarcane and bajri is superior to jowari. With proper management, a variety of market garden crops can be raised on sewage with profit. With the exception of grape vine all the fruit trees throve well and gave high yields. Betel vine flourished on effluent and brought at least as high returns as well irrigation. All fodder crops grew well on effluent mixture and gave much higher yields than those obtained by ordinary irrigation. (Inglis, *Bombay, P. W. Dept. Tech. Paper*, No. 17, 1927.)

The foregoing observations are highly suggestive, but further work is needed to place them on sound scientific basis. The conductivity method of measuring nitrogen is highly ingenious, but the results do not differentiate between the effect due to the small quantities of nitrogen thus measured and that caused by much larger quantities of other electrolytes present together with it. The statement that neither the soil nor the plants raised thereon is adversely affected by continued application of concentrated sewage is rather bold and will not be supported by other observers. Further systematic work on market garden crops, fruits and fodder crops is required before any definite conclusion could be drawn.

The sewage farm attached to the Indian Institute of Science, Bangalore, was started by Prof. G. J. Fowler in 1922 and has since been in continuous service. The researches conducted thereat relate to: (*a*) the effect of continuous sewage treatment on soil conditions, (*b*) response of different market gardens, fruit, grain and fodder crops to sewage irrigation, (*c*) relative fertilizing values of different types of sewage sludges, raw sewage, effluents from activated sludge and septic tanks and dilutions thereof, (*d*) physiological response of crops raised on sewage, (*e*) study of plant diseases associated with sewage farming, and (*f*) the nature of the morphological and physiological transformations that attend the pathogenic and putrefactive organisms normally present in sewage under conditions relating to sewage farming.

The results of the investigations show that under continuous irrigation with moderate quantities of sewage the electrolytes tend to increase though the organic matter does not persist: even before reaching the stage of sewage sickness the soil attains a condition when either irrigation with water or a few showers of rain or fallowing becomes necessary prior to resuming cultivation operations. Generally, leaf crops respond better to sewaging than grain or fruit crops but even then frequent fallowing and rotation of crops is necessary to maintain high yields. The fertilizing value of activated sludge is higher than that of the chemically precipitated one, but in the latter case it is difficult to differentiate between the effect due to the sludge and that to the chemical precipitant: it is distinctly higher than that of farmyard manure or any similar synthetic preparation. The effluent from septic tank is richer than

that from activated sludge but it has to be diluted about 3 times with water before it can be safely applied to farm crops in general: even activated sludge effluent proves to be too rich in certain seasons and could be profitably used only after dilution. Comparative pot and plot culture trials with grain and fodder crops have shown that, when irrigated with diluted effluent, plant growth is quite normal, but the yields are limited by the organic matter and phosphate contents of the soil. With regulated irrigation and adequate drainage the crops raised on previously treated and diluted sewage are perfectly healthy but under other conditions, various difficulties are encountered. Excessive sewaging leads to crop lodging: inadequate drainage or failure to fallow at frequent intervals discourages plant development and leads to a variety of diseases, particularly root and stem rots: untreated sewage would often appear to contain insect pests which tend to destroy many of the crops. The fate of pathogenic and putrefactive organisms generally associated with sewage is still obscure as they could not be readily fallowed in the soil, but further work is in progress to elucidate the position.

The researches at Bangalore would appear to form a useful complement to those at Poona, but they still lack precision and more quantitative data are required to further substantiate the conclusions stated above.

Valuable work has been done by Temple and his colleagues at Jamshedpur where a big sewage farm is being maintained successfully on wet activated sludge alone. In the course of their experiments they found that "the plot irrigated with clean water and not manured produced green fodder crop at the rate 700 lbs. per acre. Another irrigated with activated manure recommended by the Poona Agricultural College produced 15,000 lbs. per acre; and a similar plot, treated with the same amount of nitrogen as in the former case, in activated sludge, produced 30,000 lbs. per acre." [Temple, F. C., *Trans. Inst Conf. San. Eng.* (London), 1924, 102.]

The above observations are highly suggestive but it is doubtful if they could be applied to different soil conditions: the heavier types, in particular, do not permit of ready drainage and would soon get sewage sick if plied with wet sludge. Moreover, activated sludge is not purified sewage and would readily undergo septic action wherever it is allowed to stagnate.

The sewage farm at Dacca was under the management of the Public Health Department of the Government of Bengal between 1923 and 1930. During that period considerable amount of fundamental work was carried out investigating the best means of utilization in dry as well as wet weather. During the dry season fodder as well as market garden crops thrive on sewage effluent but the latter have not, so far, proved quite paying. During the flood season, when the land is too wet to irrigate, the effluent is discharged into large dilution tanks, 14 acres in extent, and thus disposed of.

The experimental sullage farm at Lyallpur, Punjab, was put into operation in 1917 and was under continuous observation till 1924. A number of useful data were collected, but owing to the uneven fertility of the experimental area and the rapidly fluctuating nitrogen content of the soil the results could not be regarded as being quantitative. Among the crops experimented with, green fodders, vegetables, and sugarcane gave the most satisfactory response; maize and oats did fairly well but wheat tended to lodge and underground vegetables cracked and burst owing to excessive enrichment of the soil (Lander, P. E., *Agric. Res. Inst., Pusa,* Bull. No. 157, 1925).

Benefitting by the experiences of Poona and Bangalore, the Drainage Department of Hyderabad, Deccan, has recently (1931) launched on a fairly large scheme of irrigation with the effluent discharged from the septic tanks treating the sewage of the City of Hyderabad. An area of 3000 acres has been set aside for the irrigation but so far, only about 1000 have been brought under the plough. An experimental farm covering about 100 acres has also been started and the requirements of crops like sugarcane, perennial fodder, fruits and vegetables investigated.

The Municipal Farm of the City of Bangalore is being managed by the Horticultural Department of the State. The Mysore City farm is administered by the Municipality but is under the technical supervision of the Public Health and the Agricultural Departments. A number of crops—particularly green fodder and vegetables—are being raised with success. A unique feature in both the above centres is the avidity with which enterprising private growers utilize all available supply of sewage.

In the province of Madras, sullage is being used, whenever possible, for permanent

grasses and fodder crops but, so far, no systematic work has been undertaken on the utilization of sewage for raising grain or remunerative crops. An activated sludge plant has recently been installed at the Agricultural Research Institute, Coimbatore, and experiments utilizing the sludge as manure and effluent for irrigating remunerative crops have been undertaken.

Interesting experiments on the relative values of effluents and sludges from sewage treated in different ways are in progress in the farm attached to the City of Nagpur. Mention should also be made of the work carried out at Nasik, Indore and different other cities, but the present space is hardly adequate to do justice to them all.

Although much useful headway has already been made, a great deal yet remains to be done. The system of irrigation has still to be improved so as to secure maximum benefit from all the plant nutrients present in sewage. The dangers of crop lodging have to be avoided without sacrificing the fertilizing value of nitrogen. The conditions relating to the application of sewage to grain and remunerative crops have yet to be standardized: crop requirements of ingredients other than those present in sewage have to be determined and judiciously applied. The quality of crops raised on sewage has to be systematically investigated with particular reference to taste, keeping and nutritive value. The transformations attending the various pathogenic and putrefactive organisms normally present in sewage have to be carefully determined and the relation of those organisms or the products of their metabolism to plant development, animal health and human welfare elucidated. In view of their importance in relation to both agriculture and public health, it is to be hoped that the above and related problems will soon receive the necessary attention at the hands of the workers concerned and that sewage farming will, before long, be placed on a sound economic and hygienic basis.

A Note on the Expanding Universe.

By Prof. A. C. Banerji, M.A., M.SC., F.R.A.S., *Allahabad University.*

EDDINGTON has shown that Einstein world is unstable and that any small disturbance would start it expanding or contracting. He has also shown that conversion of matter into radiation tends to retard expansion (*M.N.R.A.S.*, May 1930), whereas McVittie has found in his revised investigation that the effect of gradual condensation of matter into galaxies would tend to cause expansion (*M.N.R.A.S.*, Jan. 1931). The shift, towards the red, of the spectral lines of the light emitted by very remote objects like spiral nebulæ is responsible for the assumption that these bodies are receding from us, and consequently the Universe is expanding. Hubble and Humason formulated from available data the following velocity-distance relation of the receding object within an error of 10%,

$$\text{Velocity (in km. per sec.)} = \frac{\text{Distance (par-secs.)}}{1790}$$

(*Astrophysical Journal*, Vol. LXXIV, 1931.)

This corresponds to a velocity of 558 km. per sec., per million par-secs. This is equivalent to a velocity of about $\frac{1}{1800}$ of the velocity of light for a distance of a million light-years. Calculating on this basis we see that a nebula which has receded to a distance of 1,800 million light-years ought to have the limiting velocity equal to that of light, and the limiting volume will then be nearly three times that of the Einstein's static Universe, which is supposed to have a radius of about 1,200 million light-years. When the Universe has expanded to this limit, several difficulties arise and it becomes a legitimate question to ask as to what would now happen to the Universe. Dynamically, matter cannot have any velocity greater than the velocity of light. But it has, on the other hand, been suggested that matter possessing velocity greater than that of light belongs to a different disconnected world which cannot bear any physical relation to us. This is only a suggestion and its validity or otherwise can be determined only by subsequent work. It is also possible to make another suggestion. If, due to any causes (of which we have so far no evidence), as soon as the particles of the nebula attain the velocity of light they are transformed into radiation, then such a process, as shown by Eddington, would check expansion, and the Universe may

subsequently begin to contract. Now, moreover, mass (relative-mass) of a receding nebula becomes infinite when in the limit it attains the velocity of light, and consequently the total mass of the Universe becomes infinite. When nearing this limit the mass of the Universe increases very rapidly, and the structure of the Universe would then be like an expanding hollow shell with increasingly dense matter on the surface and comparatively little mass inside. One may ask if the conservation of mass (relative-mass) is an invariable law of Nature (Eddington, *The Mathematical Theory of Relativity*, p. 33), then how has this increase in mass been brought about? Or, shall we have to say that the mass also is not conserved? One is confronted with a similar difficulty in the theory of Special Relativity. Suppose we have two particles of rest masses M and M′ (with respect to each other) moving relative to each other, then we can calculate the total mass of the system in two different ways. If M be assumed to be at rest and M′ moving with a velocity V, then the mass of the latter changes and becomes $\frac{M'}{\sqrt{1-\frac{V^2}{c^2}}}$ where c is the velocity of light, and the total mass of the system becomes $M+\frac{M'}{\sqrt{1-\frac{V^2}{c^2}}}$ with respect to the first. On the other hand, if we suppose M′ to be at rest and M to be moving with velocity —V, then the total mass of the system comes out to be $M'+\frac{M}{\sqrt{1-\frac{V^2}{c^2}}}$ with respect to the second. These two expressions for the total mass are different. In the first case the total energy of the system (apart from interaction energy which, if any, will be the same in both the cases) is

$$Mc^2+\frac{M'c^2}{\sqrt{1-\frac{V^2}{c^2}}} = Mc^2 + M'c^2 + \tfrac{1}{2}M'V^2$$

neglecting terms of higher orders. In the second case the total energy (apart from interaction energy) neglecting terms of higher orders, comes out to be

$$M'c^2 + Mc^2 + \tfrac{1}{2}MV^2.$$

These two are different and the law of conservation seems to fail. It is well known that the Principle of Relativity has been developed from the motion of one body, and no way has yet been found for treating the motion of two bodies moving relatively to each other and possessing inter-action energy. The necessity for development along these lines is very great because, without some guiding light about this problem, it is not possible to make any progress in the study of the Universe as a whole, as has been pointed out in this note, and also in the Study of Nuclear Physics.

The formula for the rate of the expansion can be put as $\frac{da}{dt}=\sqrt{\tfrac{1}{3}a^2\lambda - 1 + \frac{4M}{3\pi a}}$, where M is the mass, a is the radius of the Universe at any time and λ is the cosmical constant in Einstein's gravitational equation. (*M.N.R.A.S.*, May 1930.)

When $M \to \infty$, $\frac{da}{dt} \to \infty$.

As matter cannot have any velocity greater than the velocity of light, the above equation breaks down as soon as the receding nebula attains the velocity of light. It has been calculated that the radius of the Universe (Einstein Universe) was originally about 1,200 million light-years. So, when it began to expand, the nebulæ near about its boundary must have started with a velocity equal to $\frac{2}{3}$ of the velocity of light. Hence, at the present moment these nebulæ must have a velocity greater than this. This extraordinarily high velocity as well as other difficulties mentioned above throw a reasonable doubt on the theory of expanding Universe, and the cause of the shift of the spectral lines may be looked for elsewhere.

Milne has tried to explain the receding motion of the nebulæ by abandoning the notion of curvature and expansion of space and by regarding the observed motions of the distant nebulæ as their actual motions in Euclidean space (*Nature*, July 2, 1932). In his distribution-law for the velocities of particles, he permitted a continuous distribution of velocities up to c, the velocity of light, which does not appear so probable for a particle. The velocity of a nuclear electron is also supposed to have a velocity practically equal to that of light. The same difficulty crops up again, *i.e.*, the mass of the electron as well as of the particle becomes infinite.

Macmillan supposes that there is a leakage of energy from the light quantum or photon in its long journey of millions of years from the distant nebulæ due possibly to collisions with other photons, or perhaps to an inherent instability in the photon, so that

frequency diminishes with energy and the spectral lines are shifted towards the red (*Nature*, January 16, 1932). His suggestion deserves more notice than it has so far received. He supposes that the rate of the loss of energy per unit distance from the photon to its total energy is constant, *i.e.*, $\frac{1}{\epsilon}\frac{d\epsilon}{dx} = -\alpha$, where $\epsilon = h\nu$, h being the Planck's constant, ν the frequency and α a constant. We get ultimately $\nu = \nu_0 e^{-\alpha x}$. His first suggestion that the loss of energy may be due to collisions with other photons is not borne out by any physical evidence; for example, recent experiments on the collision of photons have yielded negative results, and, moreover, according to Bose statistics it is inherently impossible for two photons to collide.

It is possible that photon may lose energy by passing through intervening gravitational matter, but unless the density of this matter is uniform throughout the whole track of the photon, the above rate for its loss of energy will not remain constant. If mass or energy is not conserved, it is then possible that photon may lose its energy due to some sort of inherent instability, but no physical evidence is yet forthcoming to show if it is actually the case. It seems probable that if this suggestion be worked out, a true explanation of the shift of the spectral lines may be found.

Letters to the Editor.

Yellowing of Sugarcane in the District of Saran in North Bihar.

IN the Government Farm at Sepaya, a kind of unhealthiness has been noticed, since 1925, occurring in sugarcane, particularly in the variety Co 213, between the months of July and September during breaks in the monsoon after some heavy showers of rain. This is the time that canes make a rapid growth, but apparently sound plants suddenly show, on the tips of the fourth (or the fifth) leaf, a yellowing which travels rapidly down and affects the whole leaf. The top leaves become pale quickly and the plant ceases to grow. The old roots are found to have decayed and new roots are not formed. The cane remains long in this condition and then withers.

The first signs of distress are seen in canes growing on light soils and in soils having a high concentration of soluble salts the $(OH)'$ ion concentration being such as to raise the pH value to 9.0 or higher. The yellowed leaves show a large accumulation of carbohydrates in them, but their nitrogen content is low. Thus a physiological unbalanced C : N ratio sets up. In healthy plants this ratio of carbohydrate to nitrogen does not exceed a third of what is found in unhealthy cases.

Stirring up of the soil followed by irrigation checks the disease, but good and quick results follow the application of nitrogenous or nitrogenous and phosphatic fertilizers and a fresh earthing up. The plants throw up new roots, yellowed leaves turn green and growth starts again. The cause of the sickness appears to be a deficiency of available nitrogen in the soil due to retarded nitrification just when the growing plants are making a heavy demand on it. Any treatment which quickens the rate of nitrate formation and holds them up to the plants makes the canes recover and grow healthy again.

M. N. GHOSH.

Agricultural Research Institute,
Sabour,
November 6, 1932.

The Effect of Low Pressure on the Life of Liquid Drops on the Same Liquid Surface.

THE effect of low pressure on the life of liquid drops on the same liquid surface was studied by means of a bottle of 1 litre capacity fitted with a mercury manometer, a three way stop cork and a vacuum pump. The primary drops as well as the secondary drops of Boys' soap solutions were formed by means of a burette fixed into the mouth of the bottle, at different pressures of the air inside it. The following results have been arrived at, from the observations taken:—

1. That the life of the floating drops on the same liquid surface depends upon the pressure of the air (or the surrounding medium). The lesser the pressure of the air the shorter is the life of such drops.

2. That the life comparatively decreases rapidly in the beginning, but slowly afterwards with the decrease of pressure.

3. That the life of such drops remains almost the same for all pressures within the range for which Boyle's law is approximately true.

4. That the formation of such drops becomes impossible when the pressure is reduced to about 5 c.m. mercury column or less.

The above results also confirm the theory of thin layer of air (or cushions) supposed to support the liquid drop on the same liquid surface and many other results obtained by the author in his previous papers.*

L. D. MAHAJAN.

Physics Laboratory,
Mohindra College, Patiala, India,
October 24, 1932.

*1. J. B. Seth, C. Anand and L. D. Mahajan, "Liquid Drops on the Same Liquid Surface," *Phil. Mag.*, **1**, 247.

2. L. D. Mahajan, "The Effect of the Surrounding Medium on the Life of the Liquid Drops," *Phil. Mag.*, **10**, 383.

3. L. D. Mahajan, "Liquid Drops on the Same Liquid Surface," *Nature*, **126**, 761; **127**, 70.

4. L. D. Mahajan, "The Effect of the Disturbing Factors and Temperature on the Life of Liquid Drops on the Same Liquid Surface," *Zeitschrift für Physik* (in press).

5. L. D. Mahajan, "Size of the Liquid Drops on the Same Liquid Surface," *Current Science*, **1**, 100.

On the Nuclear Spin of Arsenic Atom.

IN a recent note in *Current Science* it was reported by the author that continuing his work on the gross multiplet analysis of the first spectrum of Arsenic, hyperfine structures of all the prominent spark lines in the region 6300–4000A have been analysed and that the structure and intensity of the patterns were interpreted by attributing a spin moment of 3/2 to Arsenic. According to Aston's researches Arsenic is single and has consequently got but one type of nucleus. It is therefore particularly suited to the study of hyperfine structure. Tolansky has since published the results of his fine structure measurements on As. II. He based his studies on the unpublished data of K. R. Rao *re.* the gross multiplet analysis. It is surprising to find that the structures of some important lines differ markedly from the results of the writer. The lines 6110, 4888, 4708 have been described by Tolansky as single, showing no trace of structure even with 2½ millions resolving power. Only, the two lines 6110 and 4708 showed distinct broadenings towards the red. The hyperfine structures were studied by the author, using a quartz L. P. (8 mm. × 200 mm.) and a glass L.P. (4·8 mm. × 135 mm.) and fused silica etalons. For photographing the region 6300—5900 Kodak hypersensitive panchromatic plates were used and for the region 5900—5000 Mimosa finogram orthochromatic plates were used. The following table gives the result of the author's analysis for the above lines:—

λ	$\Delta\nu\ 10^{-3}\times cm^{-1}$			
6110	—309;	285;	200;	0
4888	0	210	650	
4708	0	82	150	

Fig. 1 is the microphotometric trace of a quartz Lummer pattern of 6110. It will

Fig. 1.

be seen that the line has 2 faint satellites in addition to the strong one at $\Delta\nu=200$. The line 4888 shows a fairly strong satellite at $\Delta\nu=650$ while on some plates another faint satellite at $\Delta\nu=210$ is also shown.

The line 4370 ($4p^1\,{}^3D_3$—$5p^1\,{}^3D_2$) has been studied in detail with a view to fix the fine structure intervals of $4p^1\,{}^3D_3$ term and is found to be a group of at least 4 components having the following structure:—

$\Delta\nu\ cm^{-1}$
0·000
0·260
0·485
0·635

This line does not seem to have been studied by Tolansky. He reported, however, fine structure measurements for 4340. During the past few months the author photographed the discharge tube spectrum of Arsenic under different conditions of excitation. The line 4340 was not found in any of the spectra. It is quite possible that the structure given by Tolansky for 4340 is actually for 4370.

Taking the known intervals of $5p^1\,{}^3D_2$, the observed structure of 4370 gives 350, 280

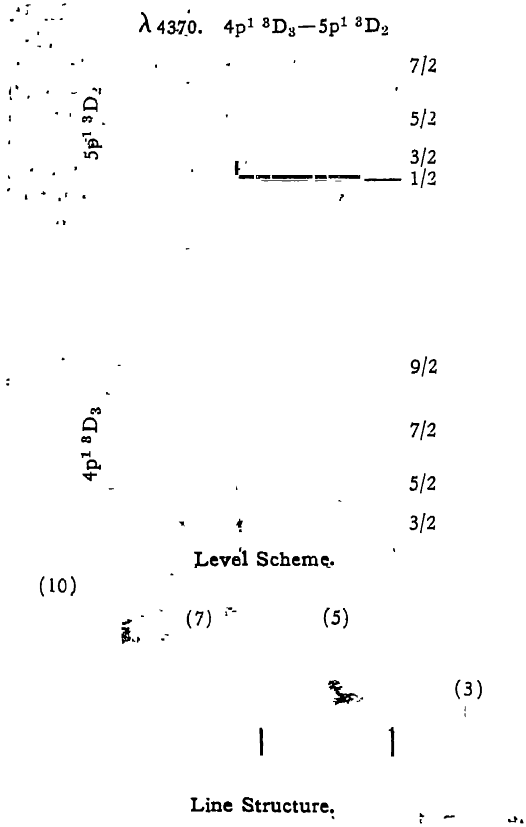

Fig. 2.

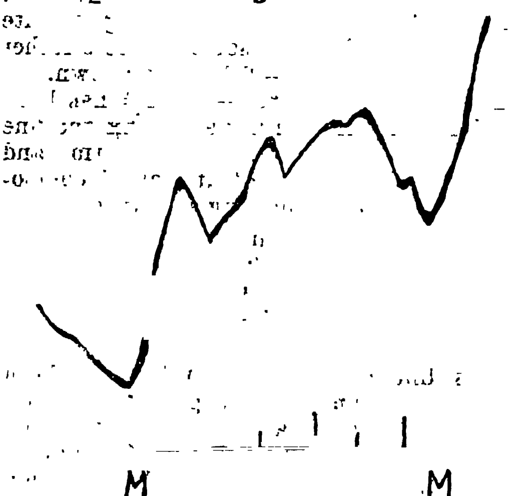

Fig. 3.

Microphotograph of a glass Lummer pattern of λ 4370.

and 195 as fine structure intervals of $4p^1\,{}^3D_3$. The level scheme and line structure are given in Fig. 2 and the microphotograph of a glass Lummer pattern is given in Fig. 3.

These experiments were carried on on spectroscopic section of the Solar Physic Observatory, Kodaikanal, and a full accoun of the results will be published elsewhere.

A. S. RAO

Andhra University,
Waltair,
November 5, 1932.

Proc. Roy. Soc., A, **137**, 541.

On the Breeding-Habits of *Gecko verticillatu*

ACCORDING to Theobold[1] a female of th species *Gecko verticillatus* lays about eigh hard-shelled white eggs, as big as musket ball cementing them to trees, rocks o secluded cracks in buildings. We mad observations of the breeding-habits of thes animals both in their natural state and in th laboratory and we found quite a differen condition. These creatures lay generall two eggs and sometimes only one but neve more than two. They have another pecu liarity of laying eggs. Gravid females ir habiting the same locality lay eggs at particular spot and they generally lay on after another at the same spot, creating bunch consisting of so many chains of eggs We reared in our laboratory a number c these creatures in a cage and they laid number of eggs, each one laying two an some only one, but never any one mor than two. A photograph of a chain c eggs in a cage is given here (Fig. 1). At

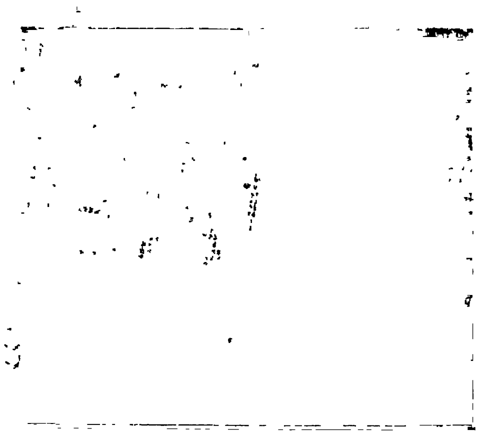

Fig. 1.

Part of the cage showing a chain of eggs and a few adult *Gecko verticillatus*.

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[1] Gadow, *Cambridge Natural History*, p. 51 1923.

particular spot a dozen or more of these could be found. This probably led Theobold to record the reason of his observation as he did. *Gecko verticillatus* generally lays eggs at a particular spot either on trees or on old houses for succeeding years and we are

Fig. 2.

Part of the bunch of old egg shells and a few newly laid ones of *Gecko verticillatus*.

giving a photograph of a part of such a bunch of old egg-shells and a few newly laid ones (Fig. 2).

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November 4, 1932.

On the Morphology of the Vertebral Column of *Rhacophorus maximus*.

BOULENGER[1] has stated with regard to the vertebral column of Anura, that "In those forms in which the vertebræ are procœlous the eighth is biconcave; the ninth being invariably biconvex." Gadow[2] has supported the statement of Boulenger. Nicholls,[3] from his study of fifty vertebral columns comprising forty species of *Bufo*, has come to the conclusion that the eighth vertebra in all cases is procœlous and the ninth has a cavity in front and two condyles at the posterior end to articulate with the urostyle. Further, he regards this condition as "apparently diagnostic of the genus *Bufo*". Recently I examined the vertebral column of *Rhacophorus maximus* (*Ranidæ* family) and found that the eighth vertebra is procœlous as in *Bufo* and not biconcave. The transverse processes of the ninth vertebra, however, resemble those of *Rana temporaria*, being directed downwards (Fig. 1).

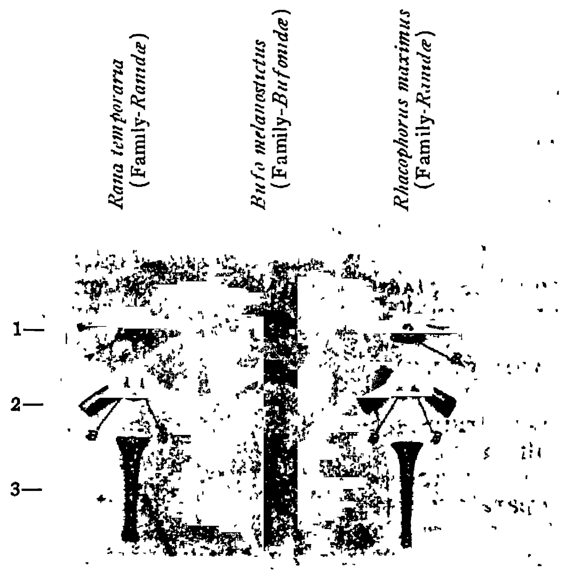

Fig. 1.

A—Socket *B*—Condyle

1—8th Vertebræ 2—9th Vertebræ 3—Urostyles

Figure shows the structural peculiarities of 8th, 9th vertebrae and the urostyle of *Rana temporaria*, *Bufo melanostictus* and *Rhacophorus maximus*.

The occurrence of the procœlous condition of the eighth vertebra, which bears the semblance of a character diagnostic in value, in both *Bufo* and *Rhacophorus* as they belong to different families, is highly interesting and whether the same condition exists in other genera is worth consideration before any generalization can be made. Evidently

[1] Boulenger, *Tailless Batrachia of Europe*, p. 38, 1897.

[2] Gadow, *Amphibia and Reptiles*, p. 20, 1923.

[3] Nicholls, "On an Apparently Distinctive Character of the Genus *Bufo*," *Nature*, **94**, 421, 1914.

Boulenger and Gadow are wrong in making a generalization and the procœlous eighth vertebra is not peculiar to *Bufo* alone.

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November 7, 1932.

Contraction Constants of Enzyme-Substrate Systems.

A DILATOMETRIC study of the enzymic hydrolysis of three glucosides, amygdalin, arbutin and salicin, has been made by means of the dilatometer described before.[1]

The amount of reducing sugar liberated in a given period is proportional to the volume change occurring in the dilatometer. The contraction constant per gram molecule of the glucoside is calculated from the observed depression and the corresponding amount of glucoside hydrolysed.

Emulsin-salicin system gives a contraction constant of 4·10. In the case of emulsin-amygdalin and emulsin-arbutin, however, no volume change could be observed during hydrolysis.

The hydrolyses of the two colloidal polysaccharides, starch and glycogen, by four different diastases, pancreatin, ptyalin, malt diastase and taka-diastase, have also been, separately, investigated in the dilatometer. The contraction constants of these systems are calculated on 100 g. of the substrate.

	Pancreatin	Ptyalin	Malt diastase	Taka-diastase
Starch	0·68	0·67	0·79	1·57
Glycogen	0·45	0·83	0·54	1·47

The constants tabulated above reveal that starch is hydrolysed by pancreatin and ptyalin to very nearly the same extent while malt and taka-diastase carry the reaction to a further stage, taka-diastase effecting the maximum hydrolysis. In the case of glycogen, pancreatin gives the least and taka-diastase the highest depression.

In every case the reaction has been followed by an entirely independent chemical method involving the estimation of the reducing sugars released during the hydrolysis. It is, therefore, possible to correlate the total depression with the amount of sugar liberated and arrive at another constant which has a relation to a gram molecule of the sugar.

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Department of Biochemistry,
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November 22, 1932.

[1] *J. Indian Inst. Sci.*, **15A**, 17, 1932.

Use of Smear Technique for Chromosome Counts in Rice (*O. sativa*).

N. S. RAO[2] (1929) has determined th diploid number of chromosomes for rice working with root tips. He states that i was not possible for him to obtain th haploid counts by 'smear preparations' o anthers, although he worked with hundred of them collected at all hours of the day, an concludes that the reduction division in ric might be taking place some time before sun rise.

Recent work at the Paddy Breedin Station, Coimbatore, has, however, definitel shown that it is possible to make haploi counts of chromosomes in dividing polle mother cells by using the smear technique Right kind of buds, which is easily deter mined by working with progressively younge ones, teased and examined in Aceto-Carmin between the hours of 11-30 and 1 o'clock o bright sunny days showed all stages of firs and second divisions. The photograph show cells with chromosomes in early metaphase and in one of the cells, the chromosomes ar easily counted. Permanent paraffin section of anthers, fixed during the period, have als

[2] *Jour. Indian Bot. Soc.*, **8**, Nos. 2 and 3.

been found to show all stages of nuclear divisions in pollen mother cells.

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Some Cranial Characteristics of Indian Engystomatidæ (Anura).

IN order to establish the exact systematic position of the group Engystomatidæ, all the systems of organs from a developmental standpoint and also from the standpoint of comparative anatomy, in the locally occurring three genera, Cacopus, Kaloula and Microhyla are receiving our attention.

The sections of the decalcified heads of the adults of these three genera reveal the following interesting features. The nasal region no doubt exhibits a complicate mechanism, and Gaupp in his 'Anatomie des frosches' (Bd 3, 1904) has described in the frog in detail the dispositions of the elements that go to form the olfactory capsule.

E. O. Lapage[1,2] has described in Urodela and Anura the disposition of the septomaxillary bone and De Villiers[3,4] has also referred to the occurrence of the same bone in the South African forms, Phrynomerus and Cacosternum. The former author dealing with the Urodela, while emphasizing the cartilaginous origin of the septomaxillary regards the function of the bone to be, for the origin of musculus dilator naris accessorius; further where the bone is absent the muscle is also reduced. De Villiers making no reference to this author in his paper on 'Phrynomerus'[3] remarks thus "the septomaxillary may justly be considered as a membrane bone primarily of the lamina superior cristæ intermediæ, which is its main support." In Cacopus, Microhyla and Kaloula the septomaxillary—an irregularly horse-shoe-shaped bone is situated just in front of the planum terminale of the cartilago obliqua and I am inclined to believe on the evidence furnished by my preparations of the tadpoles that the bone is of cartilaginous origin. It is no doubt closely attached to the lamina superior cristæ intermediæ.

In the metamorphosing phase of Cacopus prior to its assumption of a terrestrial life, there is an anlage of a single prechoanal sac. Into this sac the two choanæ open (Fig. 1).

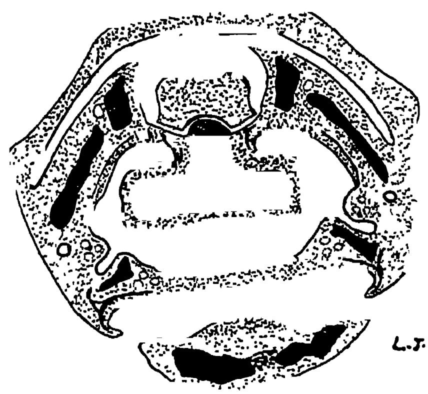

Fig. 1. Cacopus.
(camera lucida tracing.)
obj. 1 × eyepiece 1. Leitz.

a.p.s. anlage of the prechoanal sac.
B.c. Buccal cavity.
ch. Choana.
L.c. Lymph space.
L.J. Lower jaw.
r.l. Lateral recess.

This sac is, however, absent from the other two genera.

In the otic region the common presence of an "extra-plectral" cartilage embedded in the tympanic membrane is observed. Remarkably, however, like their South African congeners, the skin covering this portion of the ear region remains unmodified, giving rise to the oft-quoted phrase "hidden tympanum". So also the incompleteness of the annulus tympanicus. The eustachian tube in Microhyla and Kaloula is proportionately large for the size of the individual, while it is extremely narrow in Cacopus. This point is very well illustrated by Fig. 2. It should also be pointed out that the upper and lower horns of the process basalis and the "transitional" cartilage are reduced in size. The formation of the paraquadrate and the quadratomaxillary will be dealt with later.

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1 E. O. Lapage, "The septomaxillary, 1. In the amphibia urodela," *Journ. Morph.*, **45**, No. 2, 1928.

2 E. O. Lapage, "The septomaxillary of the Amphibia anura and the Reptilia," *Journ. Morph.*, **48**, No. 2, 1928.

3 C. G. S. DeVilliers, "On the cranial characters of the South African Brevicipitid, Phrynomerus Bifasciatus," *Q.J.M.S.*, **73**, Part 4, 1930.

4 C. G. S. DeVilliers, "The cranial characters of Brevicipitid, Cacosternum," *Q.J.M.S.*, **74**, Part 2, 1931.

In Cacopus, Devanesan[1] has described in the pharyngeal region a peculiarly modified structure which is glandular in nature as the "pharyngeal organ". In this example the epithelium of this glandular part also furnishes the lining membrane of the eustachian passage. The so-called "pharyngeal organ" is absent, however, from the other two genera and the epithelium lining the eustachian passage is simple.

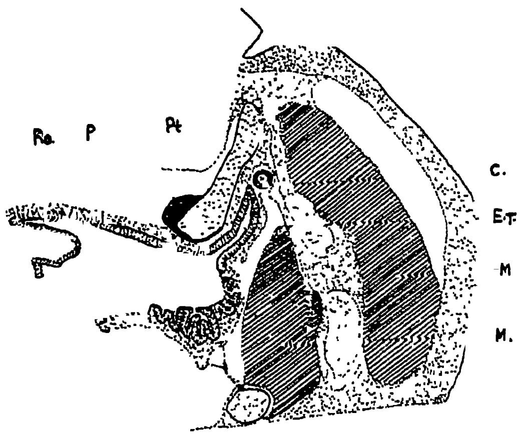

Fig. 2. Cacopus.

(camera lucida tracing.)
obj. 2 × eyepiece 1. Leitz.

C. Columella.
E.t. Eustachian tube.
M. Muscle.
P. Pharynx.
P.o. Pharyngeal organ.
Pt. Portion of pterygoid.

The pars ascendens plectri, a piece of cartilage establishing connection between the crista parotica and pars externa plectri is to be seen only in Kaloula.

The operculum is a cup-like cartilage usually associated with a pars interna plectri. The operculum carries a knob in all the three forms for the attachment of the opercular muscle.

The tadpoles of all the three genera are being examined and a detailed paper will be shortly published elsewhere.

L. S. RAMASWAMI.

Department of Zoology,
Central College, Bangalore,
December 1, 1932.

[1] D. W. Devanesan, Notes on the anatomy of Cacopus systoma, *P.Z.S.*, 1922.

On Thermal Ionisation in Dwarf Stars.

IN recent years, Chandrasekhar, Majumdar and Kothari and Milne[2], have deduced generalized formulæ for stellar ionisation for the degenerate and relativistic cases. Chandrasekhar and others, however, conclude that stellar matter in dwarf stars is not ionised at all, a result in direct contradiction to the assumptions of Fowler, Stoner and others[3]. The author has recently deduced the following expressions for thermal ionisation :—

$$ln\frac{n}{n_+} = \frac{x}{\text{KT}} + \frac{4.453\times n^{2/3}}{10^{\prime\prime}\times \text{T}} - \frac{\text{T}\times 1.845\times 10^{10}}{n^{2/3}} \quad (1)$$

(Non-relativistic, electrons degenerate.)

$$\frac{n_+ n_-}{n} = 8\pi\left(\frac{\text{KT}}{hc}\right)^3 e^{-x/\text{KT}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

(Relativistic, non-degenerate.)

$$ln\frac{n}{n_+} = \frac{x}{\text{KT}} + \frac{hc}{\text{KT}}\left(\frac{3}{4\pi}\right)^{1/3} n_-^{\frac{1}{3}} - \frac{\pi^2}{3}\frac{\text{KT}}{hc}\left(\frac{4\pi}{3}\right)^{1/3} \Big/ n_-^{1/3} \quad (3)$$

(Relativistic, electrons degenerate.)

where n, n_+ and n_- are the number of neutral atoms, ions and electrons per unit volume. These agree in form with the expressions of previous authors. Now Chandrasekhar and others consider that the number of electrons is identical with the number of molecules of stellar matter, as calculated from astrophysical data for dwarf stars and take this to be of the order of 10^{30}. By using this value of n_- in their equations they obtain zero degree ionisation. But the number of molecules obtained from observed data should really be equal to the sum of those of the neutral atoms, ions and electrons taken together. For the simple case of hydrogen if x be the degree of ionisation and N the total number of particles per unit volume, we have $n = \frac{1-x}{1+x}\cdot\text{N}$, $n_- = \frac{x}{1+x}\cdot\text{N} = n_+$. Substituting $\text{N} = 10^{30}$ in the above equations, and solving graphically, it is found that complete ionisation s attained well within a temperature of 5×10^{0} °C. For complex elements, sinc

[2] Chandrasekhar, *Phil. Mag.*, **9**, 292, 1930; *Monthly Notes of Roy. Soc.*, **91**, 446, 1931.

Majumdar and Kothari, *Z. Phys.*, **61**, 71? 1930; Milne, *Monthly Notes of Roy. Soc.*, **90**, 5? 1930.

[3] Fowler, *Monthly Notes of Roy. Soc.*, **87**, 11? 1926.

Stoner, *Phil. Mag.*, **7**, 63, 1929; **9**, 944, 1930.

Eddington, *Monthly Notes of Roy. Soc.*, **92**, 47? 1932.

ionisation may take place in more than one stage, the calculation of the degrees of ionisation becomes more difficult, but even in these cases the degrees of ionisation vary with temperature and are expected to approach unity within a temperature 10^{10} °C. Considering the abundance of hydrogen in stars, and for stars having high central density and temperature (dwarf stars and even ordinary stars according to Milne's model[1]), it is concluded that stellar matter is completely ionised, thus justifying the assumptions of Fowler and others.

A. GANGULI.

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College Dupleix,
Chandernagore,
November 22, 1932.

[1] Milne, *Monthly Notes of Roy. Soc.*, **91**, 4, 1931.

Some Peculiarities in the Gametophyte of *Adiantum capillus-veneris* L.

THE study of the gametophyte of *Adiantum capillus-veneris* by the writer has brought to light a number of interesting peculiarities which it seems desirable to place on record.

Pure cultures of the gametophyte were raised from spores sown on sterilized soil. The spores are tetrahedral with only two coats and burst at the tri-radiate mark during germination. The filamentous stage is short, limited to a single cell, or sometimes 2–3 cells long. The flattening of the gametophyte begins rather early even at the second cell stage. The course of development is similar to that in *Pteris biaurita* and *Ceropteris calamelanos* (as found by the writer of which the data are not yet published) and by Goebel for *Pteris longifolia* (Goebel, *Organography of Plants*, Eng. Ed., p. 203). A spatula-shaped prothallus is first formed by the division of the cells by walls at right angles to the horizontal surface. A second lobe emerges later anew from the anterior lateral region. The two lobes are thus unequal to begin with but on account of the greater growth of the younger lobe, the prothallus ultimately becomes heart-shaped. The thickness of the cushion is variable being dependent on the age of the prothallus. The gametophyte is massive in structure. A few cases of once or twice dichotomously divided prothalli have been observed.

Collenchymatous thickenings on the cell walls of the wings characteristic of the gametophytes of *Cheilanthes farinosa*, *Adiantum caudatum* and *Polystichum auriculatum* (as found by the writer, the data of which are not yet published) are entirely absent in the present case. Dr. Horvart has described similar thickenings in the gametophytes of *Notholœna*, *Cheilanthes* and *Adiantum cuneatum* (quoted Bower: *Filicales*, 3, pp. 80, 96) belonging to the Gymnogrammoid Series. Such thickenings are also known to occur in the gametophytes of *Lygodium*, *Mohria* and *Anemia* belonging to Schizeaceæ (Bower: *Filicales*, 3, p. 96). In discussing the relationship of the latter with Gymnogrammoid Ferns, Bower has referred to the significance of such thickenings in the members of the two groups and a phyletic value seems to have been attached to these. The absence of such thickenings in the gametophyte of *Adiantum capillus-veneris*—a Gymnogrammoid Fern—and its presence in *Polystichum auriculatum*, a member of the Dryopteroid Series which has no affinities either with Gymnogrammoids or with Schizeaceæ throws doubt on regarding it as a character of phylogenetic value. It seems likely that these thickenings develop independently in the prothalli of the species restricted to dry environments as adaptations to ecologic conditions.

The gametophyte is monœcious and the sex organs usually occur interspersed on the cushion on the under surface. The antheridia are frequently found on the upper surface particularly in young prothalli in rather feeble light. Only in one case, however, an archegonium was found on the upper surface of a mature prothallus at the cushion region behind the notch.

The development and structure of the antheridium is, as usual for Leptosporangiate ferns. Some primitive types of antheridia with the cap-cell divided by one or two walls have been observed besides the normal ones. The number of sperm mother cells per antheridium varies a great deal, from 32 in the median vertical section (usual for primitive ferns) to 16 characteristic of the advanced Leptosporangiates, on the same prothallus. The gametophyte is thus peculiar in combining the features of the prothallia of primitive as well as advanced ferns. Besides, a few cases of embedded antheridia have been observed alongside the normal ones on apparently quite healthy prothallia. Such antheridia are unusual in the Leptosporangiate ferns. The dehiscence

of the antheridium follows that described by Schlumberger for *Woodsia ilvensis*. The opercular cell is thrown out bodily. The sperms show $2\frac{1}{2}$ coil with the beak slightly notched at the apex. The structure and development of archegonium is as usual for the Leptosporangiates. Only in one case three instead of the usual 2 free nuclei in the neck canal were observed.

The embryogeny has not been studied. Three, and occasionally four, sporelings have been observed growing from a vigorously growing prothallus.

The chromosomes are cylindrical elongated.

PRAN NATH MEHRA.

Lahore,
Nevember 24, 1932.

The Magnetic Properties of Nickel Colloids.

RECENT work[1] has shown that the diamagnetism of bismuth colloid depends on the size of the particle. It was felt that an extension of the work to ferro and para magnetic metals would be of interest. Accordingly, some preliminary work has been done with nickel.

Nickel colloid was prepared by the method of the intermittent current arc from an induction coil, the sparking being arranged between two nickel electrodes in normal propyl alcohol. The colloidal powders were obtained by settling or by centrifuging. Finally the powders were obtained in small bulbs and sealed. The whole work was done in vacuum so that there was no chance of the particles getting oxidised.

The values of the intensities of magnetization of the powders were determined by the Curie method in a constant field strength of about 4,500 gauss, the necessary precautions being taken.

It was found that the intensities of magnetization of the colloidal powders were in all cases *less* than that of pure nickel, the values in these experiments varying from 70 to 85% of mass value.

Attention may be drawn to the work of Montgomery[2], who working with nickel colloidal suspensions gets similar discrepancies.

Further information regarding the magnetic properties of the nickel colloids in relation to particle sizes is being obtained and the detailed results will be published elsewhere.

S. RAMACHANDRA RAO.

Annamalai University,
Annamalainagar,
November 28, 1932.

[1] For details and references to previous work, see S. R. Rao, *Ind. Jour. Phy.*, **7**, 35, 1932.

[2] C. G. Montgomery, *Phy. Rev.*, **39**, 163, 1932.

On a Fossiliferous Quartzite from the Trichinopoly Cretaceous.

IN the course of our study of the flints and cherts associated with the upper beds of the Trichinopoly Cretaceous area, we have come across a fossiliferous quartzite which we think is a very unusual type of rock. We have pointed out elsewhere that all the flints and cherts of this area are the result of silicification of original organic limestones, and have recently announced the discovery of numerous algæ in several sections of these rocks. Under the microscope these flints and cherts are, as a rule, seen to be almost entirely composed of cryptocrystalline silica. An exceptional type of silicification is the one represented by the fossiliferous quartzites now under study. Many of these quartzites are gray in colour and are more or less fine-grained; sometimes they are quite white and granular, presenting the typical saccharoidal appearance. The rock is highly fossiliferous, the organic structures—corals, and the casts of lamellibranchs and gastropods—being easily recognizable, even in hand specimens. Under the microscope, all the sections show a typical mosaic aggregate of quartz grains, thus revealing the true quartzitic nature of the rock. A remarkable feature of these quartzites is that they also reveal broad patches of algæ, mostly *Lithothamnion*. Very frequently the entire algal patch seems to be shattered and the details of the structure more or less obliterated. Now and again, however, we see the algal structures sufficiently clear to admit of easy identification, as such. A few foraminiferal sections, chiefly of the family Miliolidæ, are also seen here and there. Under cross nicols these algal patches, foraminiferal shell sections and coral sections are all seen to be uniformly resolved

Quartzite—showing corals.
About 1/5 natural size.

into a mosaic of quartz gains showing that it is a true case of a quartzite derived from the silicification of a fossiliferous rock. A fossiliferous quartzite of this nature is an unusually interesting type of rock. Dr. Lees in his paper on the Chert Beds of Palestine (*Proc. Geo. Assn.*, **39**, Pt. 4, 1928) has mentioned a similar rock type which he describes as follows:—"In some places an unusual quartzite bed outcrops interbedded with Cenomanian limestones. It is intensely white in colour and has a sugary surface texture. Mr. G. S. Blake showed me some definite, though indeterminate, fossil shapes in this quartzite which aroused suspicion as to its real nature. A thin section shows nothing but a regular mosaic of quartz crystals. Several opaque patches suggest some organic structure." Obviously Dr. Lees is here speaking of a rock very similar both in nature and origin to the type that we are now describing; but whereas the fossil shapes he has seen are "indeterminate" and "suspicious", those in our type are absolutely clear and convincing.

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November 19, 1932.

Some Physiological Investigations of Fern Prothalli under Cultural Conditions.

AN investigation of the behaviour of the prothalli of some Polypodiaceæ (*Anisogonium esculentum* Ptesl., *Pteris longifolia* L., *Goniopteris prolifera* Roxb., *Nephrodium molle* Desv.) under various physiological conditions has been carried on by the writer for some time and has produced some interesting results. In one set of cultures placed in a corner of the glass-house in which the prothalli were submerged under water, a large number of filamentous outgrowths were observed from the surface and marginal cells of the prothalli after one month. The filaments are septate, branched apparently similar to the filaments of some algæ. They grow towards the direction of light. The length of the cells in different filaments or even in the same filament is very variable. The cells formed in the light of very low intensity are much longer, narrower and with a small number of chlorophyll grains as compared with the others formed in the light of comparatively higher intensity. Usually in the same filament, the cells at the base are much longer as compared with the cells in the upper region where they become relatively more favourably placed with respect to light.

The possible factors which could have been effective in bringing about this filamentous response in flat prothalli, under the conditions in which the cultures were placed could be:

(1) Submerged condition as such;
(2) Abundance of free moisture;
(3) Feeble light.

These three factors have been isolated one by one and their effect studied. Prothalli submerged under water (supplied with nutrition) and those floated over it in the same culture have both produced such filaments, so that the submerged condition does not seem to be an influencing factor. In another experiment some flat prothalli were placed in feeble light on soil and frequently watered so that the soil remained muddy while some more were placed in identical conditions alongside except that they were given just the amount of water that would keep them living, to act as controls. After two months the prothalli of the first culture produced large number of filaments while those acting as controls kept to their normal shape. Abundance of free water is therefore one of the causal factors. In the third experiment prothalli growing on soil were supplied with abundance of water so that the soil remained muddy throughout. One of the cultures was placed in rather feeble light and another in open day-light. After 3 months there was an abundance of filament formation in the former while in the latter the usual form of the gametophyte was retained. It seems obvious, therefore, that feeble light in conjunction with abundance of free moisture is responsible for bringing about the filamentous condition—the one alone being without any result.

Bearing these results in mind, the writer next tried the gametophytes of *Adiantum lunulatum* Burm., an apogamous fern that usually develops tracheids in the general body of the prothallus. The normal form of the prothallus is cordate. Submerged under water and placed in feeble light the development of the tracheids is stopped in the tissue of the gametophyte. The prothalli lose their usual cordate form and during further growth become strap-shaped. Quite long ribbons one layer of cell in thickness and sometimes branching laterally

have thus been produced. They bear a close resemblance in form to the prothalli of Hymenophyllum. If the prothalli are kept under these abnormal conditions still longer, the straps become filamentous in their further growth. Such filaments may also be given off laterally from the straps and are algalike in habit resembling in a general way the prothalli usually described in the genus *Trichomanes*.

It has thus been possible under the influence of feeble light and abundance of moisture to convert an ordinary cordate type of prothallus first to the strap-shaped type characteristic of *Hymenophyllum* and later to the filamentous type characteristic of *Trichomanes*. It is possible that the type of the prothalli in these two species hav been produced by progressive stages reduction (in the way described above) fro the ancestral cordate type under the infl ence of the above factors which prevail i the habitats to which these species hav adapted themselves.

Another conclusion arrived at is, th submerged condition as such has a gre retarding influence on the formation of se organs on the prothalli.

PRAN NATH MEHRA.

Lahore,
November 23, 1932.

Research Notes.

Certain Pathological Effects of Ultra-Violet Radiation on Mosquito Larvæ and Pupæ.

[Malcolm MacGregor. *P.R.S.*, Ser. B., 112, **774.**]

THE effect of ultra-violet wave band upon the larvæ and pupæ has been studied and an attempt has been made experimentally to determine the wave length of radiations and to ascertain the histological and pathological nature of the injury sustained. It has been shown that the radiation causes a form of injury fatal to the insects. 'Paralysis' is generally noticeable within 48 hours after an exposure of 45 seconds from a quartz-mercury vapour lamp held at a distance of 11½ inches from the larvæ. Larvæ at all stages of development are susceptible to injury and death from exposure to ultra-violet radiation. Pupæ are considerably less susceptible and are increasingly resistant.

Paralysis is symptomatic of an histological injury. Histolysis is of a progressive type affecting cells subjected to irritation. Adjacent cells are also affected. The rate of induction of the tissue changes is directly proportional to the duration of irradiation.

The paper describes the details of the histological nature of the injury.

The Esclangon Effect and the Effect observed by Miller.

IN *Comptes Rendus*, **195**, p. 769, 1932, M. E. Carvallo has given an interesting note on the possible identity of the effect observed by Miller and that noted by Esclango It is well known that the theory of relativi was based on the null result of the Michelso Morley experiment. Many other experimen designed to detect the relative motion b tween the earth and the ether have also giv negative results. But Miller, working Cleveland and on Mount Wilson, found positive effect; the result of his experimen created a sensation in scientific circles sin it contradicted the theory of relativity. T magnitude of the effect was, however, t small to be attributed to the orbital moti of the earth through the ether. The fa that the effect was maximum when t observing telescope pointed in a north-we erly direction was also against such explanation. Miller concluded that his resu indicated a relative motion between t solar system and stellar space. Now Escla gon has shown (*Journal des Observateurs*, 1 iv, p. 49, 1928) that a ray of light reflect by a mirror which is being carried along the earth in its motion will be sligh deflected. M. Carvallo remarks that this f lows from Huyghens' construction and th the effect should be a maximum when t direction of the earth's motion is inclined 45° to the axis of the observing telescope the arrangement of Michelson and Morl This is found to be the case in Miller's periment, whereas the displacement of fring due to a difference of path should be a ma mum when the velocity of the earth parallel or perpendicular to the observi telescope. Hence M. Carvallo concluc that the effect observed by Miller is iden cal with the Esclangon effect, unless th

minute effects are both illusory. As he points out in conclusion the truth will be known when the experiments of these investigators are performed with greater precision.

Petrography of Pacific Lavas.

IN recent numbers of the *American Journal of Science* (**XXI**, 377 and 491, 1931) F. W. Barth has published an interesting paper on the "Mineralogical Petrography of Pacific Lavas". The rock-forming minerals of these lavas have been studied chemically and optically. New chemical and mineralogical data for these minerals bearing on the important question of rock differentiation are given. By the use of optical analyses in conjunction with chemical analyses, it has been shown by the author that the sequence of crystallization is parallel to the sequence of differentiation and thus it follows that the theory of crystal setting is adequate to explain the differentiation of Pacific lavas.

Separation of a Gaseous Mixture of Isotopes.

IN *Zeitschrift für Physik*, **79**, 108, 1932, G. Hertz describes a very interesting experiment designed to separate the isotopes of an element in the gaseous state. Previous attempts by Aston and by Harkins and his collaborators had resulted only in the production of a mixture in which the proportion of one of the isotopes had been slightly increased. The improved apparatus of Hertz on the other hand has enabled him to separate the isotopes in an element like neon almost completely. The method employed was the same in principle as that employed by previous workers, namely, to utilize the difference in the rates of diffusion of the components of a mixture of isotopes. The improvement consists in modifying the apparatus so as to be able to use a series of separating units together, each of which has the property of separating a continuous stream of the mixture of isotopes passing through it into two equal streams having a different composition from the incoming gas. Each separating unit consists of two tubes having porous walls, the inlet tube of one being connected by a side tube to the side outlet of the other while the direct inlet tube with porous sides continues in a straight line through both. In this arrangement the mixture of isotopes enters at the inlet of the first tube; the lighter component diffuses through the walls faster than the heavier component and is pumped out at the side-outlet of the first tube. The heavier part goes through the inlet of the second tube, but, since after diffusing out through the side outlet of this tube its composition is not altered much, it is led back to the inlet of the first tube. Then it again goes through both the tubes so that the stream coming out of the outlet of the second tube is rich in the heavier component while the stream coming out of the side outlet of the first tube is rich in the lighter component. This stream passes through the pump of the first separating unit into the inlet of the first tube of the second unit and from the side outlet of the same to the pump of the second unit and so on till from the pump of the last unit it collects in a vessel V_l. The heavier part going through the direct tubes courses in the opposite direction and collects in a vessel V_s connected to the inlet of the first unit. The disposition of apparatus is clearly shown by a number of diagrams in the paper. Hertz used first of all an apparatus with four units to separate a mixture of helium and neon and then set up an arrangement consisting of 24 units in two parallel series of 12 units each. The diffusion pumps were automatically controlled as regards the heating current of gas and cooling current of water according to the method described by W. Pupp (*Phys. Zeit.*, **33**, 530, 1932). The diffusion tubes were made by the Steatit-Magnesia A.-G. out of a fine chamotte rich in kaolin. When first a mixture of neon and helium was introduced, the vessel V_s was of 30 litres while V_l was of 5 litres. All the helium collected in V_l. After removing the helium, the 30-litre vessel was used as V_l and a vessel of 400 c.c. as V_s. The gas in V_s was taken out for testing after the apparatus had been worked for 8 hours. It was found that with the above sizes equilibrium was established in about 4 hours. In order to get a sample rich in the lighter component, the two vessels were interchanged. The various specimens were examined with a mass-spectrograph giving Thomson parabolas and also with a Fabry-Perot Etalon for fine structure. The intensity of the parabolas as well as the hyperfine structure components served to give the ratio of the two isotopes of neon. In a specimen rich in Ne_{20} the component due to Ne_{22} was absent while the two components were equally strong in a mixture having equal proportions

of Ne_{20} and Ne_{22}. When Ne_{22} was in excess the component due to it was stronger, thus showing that the percentage isotopic constitution of ordinary neon can be obtained from the ratio of the intensities of the hyperfine structure components of neon lines. In the mass spectrogram of the specimen rich in the heavier isotopes, there was a parabola corresponding to Ne_{23} besides the one due to Ne_{21}. This method seems to be promising of important results with a wide range of application including such cases as nitrogen and hydrogen where one of the isotopes is present in an extremely high proportion.

Hidden Geological Structures.

"THE limitations of ground water as aid in determination of hidden geologic structure" forms the theme of a paper by E. K. Soper published in a recent volume of the *Bulletin of the American Association of Petroleum Technologists*, **XVI**, 1932. The author points out that in these localities where the surface of the land is relatively flat without, therefore, giving any clue to the underlying structures, irregularities of the water-table, such as wide flat terraces, sharply defined artesian areas, or anticlinal bulges may be reliable indicators of the existence and location of buried structures.

Breeding of the Field Mouse.

[J. R. Barker and R. M. Ranson. *P.R.S.*, Ser. B, 112, **774**, 39, 1932.]

IN the second part of their contributions, the authors describe further experiments on the effects of light on the reproduction of the field mouse. The mice are subjected to summer conditions of temperature and food but are exposed to light for only 9 hours daily. The authors call this "the winter light experiment". In addition, mice are subjected to 15 hours of exposure to light from a 60 watt bulb and given summer food but kept at a low temperature. This experiment is called "winter temperature experiment". Under the conditions of the "winter food experiment" the mice are subjected to exposure of 15 hours of electric light and summer temperature. The animals are fed on hay, rye grass seed and a small amount of growing grass. While the control mice consumed 30 grms. of growing grass per day with no hay and grass seed, the experimental mice were given about 3 grms. of hay and 1½ grms. of growing grass and an unlim supply of grass seed.

The results of these experiments s that under the conditions of the "wi temperature experiment" the field m breeds less at low temperatures (5°C.) t at summer. The fecundity of the male not affected. The cutting down of f food to a minimum does not hinder re duction.

The Influence of the Visible and Ultra-V Rays on the Stability of Protoplasm.

UNDER this title W. W. Lepeschkin recently published an interesting p second of the series. (*American Journ Botany*, July 1932.) The author states protoplasm subjected to the action of st light is gradully disintegrated and Further, the protoplasm is specially sensi to ultra-violet rays. The cause for destruction lies in a chemical change protoplasmic proteins as shown by the w of Henri, Cleaves, Clark and Young. kinds of cells were used in the experim by the author: yeast cells and leaf cell Elodea canadensis. The poisons used alcohol and iodine and the resistance living matter to these after exposure to l was investigated. The decrease of stability of living matter produced by direct sunlight disappears soon in diffuse l on account of the synthetic processes of cell restoring the substances changed light. This process is very rapid in yeast cells. If the synthetic processes depressed by alcohol, the stability of toplasm decreases further. Among visible rays of the sunlight, green, blue violet rays are more effective than red in producing the decrease of the stabi Ultra-violet rays produce an increase of stability of living matter, the maximum b reached quickly according to the strengt radiation. If the radiation is prolonged it is strong, the stability of protoplasm decreased as in the visible rays.

Algal Limestones from Queensland.

PROF. H. C. RICHARDS and Dr. W. Bryan of the Department of Geology, versity of Queensland, have recently lished a paper (*Geological Magazine*, No. July 1932) dealing with an interesting covery near Gigoomgan, Queensland, large mass of limestone made up alr

entirely of the microscopic remains of algæ. The age of the rock is proved to be Permo-Carboniferous on other palæontological evidences. According to the authors the features of outstanding interest in the Gigoomgan limestone are: (i) the great size of the mass. (ii) the purely algal character and uniformity, (iii) the absence of dolomitisation, and (iv) the absence of associated oolites. The authors consider that the comparatively poor development of reef building corals at the time of the formation of this limestone, as compared with the present day, may have been an important negative factor contributing towards the purity of the algal reef.

Some Correlations between Skull and Brain.

THE Second David Farrier Lecture* on this subject by the eminent Dutch Anthropologist, Dr. Ariëns Kappers, forms a fitting sequence to the first, delivered by Sir Charles Sherrington. And while Sherrington dealt with the fascinating problems of the Physiology of the Brain, Kappers tends to emphasize the enormous importance of its morphology, especially from an anthropological point of view. There is probably no more fascinating subject in Anthropology than the relation between the morphological peculiarities of the Brain and the racial characters of the Skull. Indeed, an elucidation of this problem opens up a new and wide vista of understanding of the varied races of humanity. While, however, due to a large number of material and scientific difficulties, the author does not claim to present a solution to this problem, he endeavours to lay out certain lines along which the solution may be sought for. This relation between the Brain and the Skull is of deeper importance than it may at first suggest, for, while the Skull and the Brain are closely correlated regarding differences in form, the brain but reflects its intrinsic cerebral varieties.

It is interesting to see that in its turn the skull-form profoundly modifies the brain-form. This occurs in many fishes, birds and mammals. In Teleostomes, for instance, a flattening of the head in the larval stages has given rise to a compression of the brain resulting in a gradual obliteration of the ventricle of the Fore-brain by the formation of a solid mass of cells on its dorsal surface known as the Epistriatum. The cerebellum has become more compact and its cavity is almost entirely absent, while the fourth ventricle is very narrow. The same thing is found in birds also, where, due to a large quantity of brain material and the limited space that is at its disposal, all the ventricles have either become greatly reduced as in the majority of birds or are entirely absent as in parrots.

The correlations between the brain and the skull in mammals are of another type, where the body size also is responsible for the brain size. If two related species of mammals differ in size, the brain of the larger animal has the smallest length-breadth index. Again if two related species of mammals differ in cephalization coefficient, the brain with the largest coefficient has the greatest length-breadth index. An examination of a large number of related genera of marsupials, rodents, ungulates, carnivores and primates, shows, that body size remaining the same, in lesser cephalised animals the brain is more elongated, while in higher cephalised ones it is rounder. These changes in the brain form and size are not without effect on the pattern of fissuration. It has not been sufficiently realized in all cases that higher cephalization goes hand in hand with more arched and perpendicular fissuration. Comparing the brains of the dog and the bear, it is noticed that the arcuate and the coronolateral fissures are pronouncedly arched in the bear, whose cephalization coefficient is nearly twice that of the dog. The submergence and the consequent obliteration of some of the fissures from external view are only necessary results of this intense arching of the brain.

An extension of these researches into a comparison of new-born and adult mammals of the same species has resulted in establishing a relation between the actual brain weight of a fœtus or a young animal and the brain weight it should have if it were an adult of its size. By these calculations it is seen that, while in some animals like the pig and the lion the body-brain weight relation in the young is higher than in the adult, in chimpanzee and man, it is not so; in fact

* *Phil. Trans. Roy. Soc. of London.* Ser. B., **221**, B. 480.

the cephalization in these two is considerably less than in the adult. Kappers' own observations show that even in the first year, the relative brain weight of the child is less than it would be if it were an adult of the same size. This is probably why the brain of human fœtuses and new-born ones is rather long, and while the rolandic, sylvian and parietal-occipital angles are larger, the stem angle is smaller than in the adult.

The relation between the adult human skull and brain is very intimate and Kappers draws certain important conclusions as a result of his examination of a large number of skulls and brains of both Brachycephalic and Dolichocephalic types. In the first instance, his intimate and expert knowledge of these two types of skulls amongst the Dutch has led him to conclude that Brachycephalic brains have large sylvian and rolandic angles correlated with a deeper temporal lobe and a pronounced superior temporal convolution. Another feature of the Brachycephalics is the high and vertical crescent-shaped lunate sulcus, a fundamentally simian feature. In all these and other minor points the Dolichocephalics are different.

But it is really a comparison of the skulls and brains of the different human races that is of utmost interest. Based as it is on a personal examination of a large number of well-fixed brains, the statements made by Kappers are as precise as they are authoritative. Beginning with Armenians, a hyperbrachycephalic, hypsicephalic race, one is struck at once by the large sylvian angle, a deep temporal lobe and an extremely curved superior temporal convolution,—all correlated with the peculiar occipital shortening of the Armenian skull. The Lebanese brain is similar to the Armenian but the Adnan Arab brain is different from either, in both cephalic index and fissuration. A straight sylvia, a small sylvian angle and a straight superior temporal are the main characteristics of the long-headed brains of the Egyptians and the Soudanese. Poynter and Keegan have described similar relations for the brains of American Negroes, Hrdlicka and Spitzka for Eskimos and Flashman Duckworth and Woolward for Australians.

From an anthropological point of view the Mongol races are very interesting. There are two groups to be recognized, the Brachy-platycephalic Northern Mongols and the Meso-hypsicephalic Chinese. The brain weight of the former seems to be very high compared with their stature which is smaller than that of Russians whose brain weight, however, is not so high. The frontal flatness of the skull has brought about a frequent interruption of the inferior temporal fissure and deep temporal fissures in the occipital region. The Chinese brain which is primarily interesting on account of its height has been examined by a large number of workers including the author who think that in the smaller stem angle and the higher callosum index it resembles the brachy-hypsicephalic Dutch brain. Indeed, in certain other features like the steep hippocampus and the vertical crescent-like lunate sulcus the Chinese brain is so intensely brachycephalic that it has often been said to resemble the brain of the Urangutan and attempts have even been made to trace the origin of the Mongol race from this anthropoid. The Japanese skull, however, is less mesocephalic than the Chinese and its sylvian angle is larger. An examination of the brain of Bataks shows that it is just possible that in this race the female brain tends to be more brachycephalic than the male.

While so far we have been dealing with the features that are intimately correlated with the racial types of the skull, there seem to be others, especially in the fissural arrangement that do not show this correlation with the skull type. Most important amongst these are the posterior rhinal sulcus, the anterior branches of the sylvia and the lunate sulcus. While for any type of generalization, an examination of a large number of skulls and brains is necessary, this much may be said with certainty, that the breaking up of a fissural pattern, originally simple, is a direct result of an extension of function and an examination of man, both extinct and present, reveals a progressive development of certain regions of the brain, more especially the inferior frontal, which is the speech centre,—his greatest and most special distinction.

B. R. S.

Convocation Addresses.

University of Nagpur.

SIR S. RADHAKRISHNAN'S address to the graduates of Nagpur University presents a vivid picture of current social, economic and political problems which are reviewed with a sympathy and breadth of vision which characterise an eminent philosopher. The new spirit and temper animating the minds of young men is due to the emphasis on the application of science to the practical problems of human affairs and to the consciousness of social solidarity. Reference is made to Mr. Lakaminarayan's munificent bequest of forty lakhs of rupees, but the terms of the bequest and the scheme for its utilization are, in our opinion, to be carefully examined before adopting them, for there is a great deal of false glamour about starting technological institutes in the Universities for the purpose of training young men for commercial and industrial careers. Sir Radhakrishnan hopes that the proposals of the committee appointed by the University to devise schemes for the proper utilization of the donation, will give a fresh impetus to the industries of the country. We have no copy of the report at our disposal and we can only trust that the committee has not embraced the common error of suggesting technological courses being associated with a purely academic training such as a University can impart. The preparation of young men for practical careers implies training in workshops, business methods, the art of salesmanship, management of concerns large or small, skill in advertisement, marketting the productions, trade relations, foreign currency and exchange and quite a host of other matters which will make the careers profitable. Sir Radhakrishnan points out that the chief cause of unemployment in India is due to a want of application of scientific methods to agriculture and industries. The greater part of the address is devoted to an examination of the unemployment problem in India which is expected to be solved to some extent by the Government pursuing a policy of progressive industrialization. A brief summary of the statistics dealing with the percentage of population depending on agriculture and industries in the different countries is given to show that the dependence of Indians on the precarious produce from the land accounts for the greater part of the unemployment of her people. There seems to be a little fallacy in arguments based on a comparative study of statistics. Have countries like Britain and the United States which are industrialized almost to the teeth, solved their own unemployment problem? What is the percentage of the unemployed to the total population in these countries? Is it quite clear that agricultural pursuits lead directly to unemployment? The employment of machinery on a progressive scale must necessarily diminish the employment in the number of human hands in industrial organizations and if we add to this, mass production, and increasing birthrate, we have the correct picture of the problem. The theory that industrialization of a country will safeguard it against unemployment has to be examined closely with reference to other contributory causes. Speaking about the progress of civilization, Sir Radhakrishnan is reported to have said that the possibilities of the abuse of science are great and may not add to its enrichment; and "the inspiring vision of the reign of justice and fairplay on earth" such as poets and philosophers are capable of dreaming are also dreamt of by the scientists. One of the functions of science is to discover the properties of matter and the power of using or abusing them is not the attribute of the scientist. Recent advances in nuclear physics and experimental biology have given us new qualitative values which, with those derived from researches in philosophy, ought to make definite contributions to the progress of humanity. Dealing with other topics of current interest Sir Radhakrishnan points out that political emancipation alone is powerless to eradicate the many social evils from which India suffers and lays emphasis on what he calls "mental freedom" to be placed within the reach of those who are affected by social injustice. Political equality as a working hypothesis can be sustained only if opportunities for self-improvement exist in the whole community. He mentions that religion is opposed to freedom of enquiry and entrenching behind authority which is not to be questioned, it has produced misfortunes for humanity. Religion is alleged to be opposed to "Eugenic sterilization" and the practice of contraceptive methods and "social hygiene" and the removal of untouchability. We conceive the true function of religion to be to provide for the human mind a discipline of truth and to

establish an eternal communion between man and his Maker. It is essentially an affair of the heart and not of the head. Troubles arise where the latter is involved. Referring to the troubles of the present time, he is of the opinion that the greatest need is a radical readjustment of fundamental ideas, and he further points out that we have to imbibe the spirit and methods of Western scientific research and not necessarily, its results. This is a subject which requires a very careful examination especially in view of the fact that the results of the modern scientific investigations have affected every detail of our daily existence. We have no hesitation in saying that this thoughtful address provides a most useful and stimulating reading.

A.N.R.

Agra University.

In the federal type of the University of Agra, Sir Sitharam sees a great advantage of providing for a large body of poor young men aspiring for the humanising and vitalising influences of higher learning which on account of distance and other reasons will be otherwise denied to them. Judging from the number of graduates and under-graduates in the Universities of the United Provinces, he makes out a strong case for the establishment of new Universities and the consolidation of the existing ones. He pleads for the establishment of tutorial system in the Universities and his suggestions deserve careful and immediate consideration of the authorities. Most Universities have taken steps to provide for the periodical inspection of the residential quarters of their students not living in the University or College Hostels and for a general sort of supervision over their work and other activities. But this procedure requires to be systematised into a regular feature of tutorial control as an indispensable part of University work.

L.S.R.

Andhra University.

Dewan Bahadur M. Ramachandra Rao alludes in his address to the institution of the University Training Corps for Andhra Desha. We recognize the need of military training for our young men provided the necessary funds for its organization in the University should be forthcoming. Few will question the excellent educational results, such as, cheerfulness of obedience, a sense of stern discipline, a strong spirit of comradeship, resourcefulness, teamwork and self-sacrifice which a camp life will promote. Nothing is better calculated to foster the excellent qualities of true citizenship.

L.S.R.

Allahabad University.

The retiring Vice-Chancellor, Dr. Ganganath Jha, dealt in his address with the curtailment of Government grants which must necessarily impose serious handicap on the continuance of existing arrangements and their expansions in the University. It is true that more money is required for the diffusion of Elementary and High School Education in the country, but this money is not to be obtained by pinching the University grants. If we expand the lower grades of instruction, it follows that the University education also should keep pace with it. India needs every form and grade of education in a far greater measure than has been possible for the Government and the people to provide for her. His ideal of higher learning is unimpeachable. He says, "Our function mainly is to provide the country with a set of highly cultured young men who will go forth into the world and improve the level of society. Our ideal, so far, has been high culture and not money-making."

L.S.R.

Lucknow University.

Perhaps the most important portion of Mr. C. Y. Chintamani's address is that which relates to discipline, a subject which is in need, to-day, of some emphasis. He sums up the lesson of discipline in these words, the message of which is important both to the elderly citizens and the youth of the country. "Consciousness of one's limitations and of the necessity of constant self-examination and of learning from others, obedience and loyalty to the leaders, discrimination between judgment and conscience so that deference may be paid to the views of more experienced men instead of an ignorant conception of 'conscience' being made the excuse for thoughtless action based on wrong judgment, the preservation of our heritage of humility and reverence without prejudice to our readiness to act boldly on our own responsibility even if everyone

go against us when our conception of duty dictates such a course—in my humble view all these qualities are connoted by and included in the single yet comprehensive word 'discipline'.'' No harm is done if a few more substantives like 'self-sacrifice', 'service', 'tolerance' and so forth are thrown in to make the definition applicable to every form of human emotions and will. Mr. Chintamani is not satisfied with the qualities possessed by the graduates of our Universities. He says that when a graduate of average ability goes forth into the world the public have a right to expect that he possesses a certain amount of knowledge and a few other qualities without which one can do no satisfactory work in any line. He asks if this expectation is fulfilled and requires an answer from the University. From the way he puts his question, one will not be wrong in inferring that Mr. Chintamani suspects that the expectation is belied and this is a terrible indictment of the work of the Universities

M.S.M.

Patna University.

Sir Courtney Torrel in his address to the graduates complains against the introspective character of the Indian mind which needs correction by a wider and deeper infusion of objective sciences than is attempted in the Universities at present. "The Indian mind must no longer be directed inwards to contemplate the soul alone, but outwards to observe and react to the external world." There is a great deal of philosophical abstraction about the Indian mind which delights in logical sophistry and this is due to the spiritual ideals which dominate the Indian life. A corrective is necessary and we must say that the Indian student of average intellect will readily adapt himself and profit by scientific training. We are not quite convinced if the exhortation of Sir Courtney Torrel to subject all favourite theory and beliefs to the ruthless test of practical experiment is at all a practicable and desirable suggestion. If some of the more valued spiritual possessions of our race were subjected to the stern experimental tests of science,—they may not be amenable to them,—what will be the repercussions on our social systems and ethical code, if the conclusions of such scientific enquiry were to prove that the articles of faith now held by mankind have no scientific sanction. We do not believe that it was the intention of His Lordship to suggest to the young men of Patna that they should re-examine and analyse the fundamental concepts of right and wrong by the application of scientific methods ; rather we take it that it was an advice on the lines of St. Paul "Prove all things and hold fast to that which is good," and a plea for the cultivation of the faculty of observation.

M.S.M.

Science News.

A GOOD Tibetan Dictionary, embodying the results of modern researches in the fields of Tibetan linguistics and philology, has long been a great desideratum. Such a Dictionary has now been undertaken by the Himalayan Research Institute of Roerich Museum. The new Dictionary includes, besides the material found in the already existing Tibetan Dictionaries, published in European languages, the rich material found in numerous lexicographical works issued in Tibet, China and Mongolia, and up to now unexplored by Western Science. Besides the above printed material, the compilers will add a vast material collected by them in the course of their researches, and which will be published here for the first time. The Dictionary will contain the Sanskrit equivalents of important terms : loan-words, which will be traced to their origins wherever possible, and an extensive material from the colloquial language, and the various living dialects of Tibet. It is hoped to bring the Dictionary to completion towards 1934.

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The following papers were read or taken as read at a meeting of the U.P. Academy of Sciences, held on October 28th, 1932:—

"On Two Species of the Genus Cephalogonimus Poirier from Water-Tortoises of Allahabad with remarks on the family Cephalogonimidæ Nicoll." By Bindeshri Prasad Pande, Esq., M.Sc., Zoology Department, Allahabad University.

"A Note on the Expanding Universe." By Prof. A. C. Banerji, M.A., M.Sc., F.R.A.S., I.E.S., Mathematics Department, Allahabad University.

"On Some Experiments with Iodine Vapour." By G. R. Toshniwal, Esq., M.Sc., Physics Department, Allahabad University.

"Ageing of Ferric Phosphate and Vanadium pentoxide Sols at various Temperatures." By Dr. Satyeshwar Ghosh, D.Sc., and Mr. S. N. Banerji, Chemistry Department, Allahabad University.

"On the Absorption Spectra of Alkyl Halides." By Prabhat Kumar Sen Gupta,

Esq., M.Sc., Physics Department, Allahabad University.

"On the (i) Virtual Independence of the Reverberation Period in Architectural Acoustics of the Auditorium Volume, and (ii) its Dependence on Sound Frequency." By Satyendra Nath Ray, Esq.. M.Sc., Lecturer, Physics Department, Lucknow University, Lucknow.

"On the Equation of State of Saturated Vapour." By Messrs. Brij Bhusan Kak and Sushil Kumar Ghosh, Physics Department, Lucknow University, Lucknow.

"On the Relation between Energy Current incident on an Auditorium Wall and Gauss's Theorem." By Satyendra Nath Ray, Esq., M.Sc., Lecturer, Physics Department, Lucknow University.

"On the Formula for the Locus of Discontinuities in the Isothermals of Brombenzol." By Gopal Das Kshetrapal, Esq., Physics Department, Lucknow University, Lucknow.

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In a letter addressed to us Dr. H. Chaudhuri writes:—"In the course of my address as President of the Botany Section of the Nineteenth Indian Science Congress, held at Bangalore in January last, I expressed the view that 'with the increase in mycological work, the establishment of an Indian Bureau of Mycology has become an imperative necessity'. Since then I have consulted many mycological workers in this country and they all favour the idea. The *Madras Agricultural Journal* of February 1932 fully endorsed my views and suggested the establishment of a combined Bureau of Mycology and Entomology. To quote the *Journal*, 'To start with a combined Bureau of Entomology and Mycology, would, in our opinion, meet the immediate needs of the day, facilitate research in these sciences and prevent unnecessary duplication of work in different centres.' This Bureau will be of immense help to mycological workers and if a combined Bureau is established, to entomological workers also. Like the 'Centraalbureau voor schimmelcultures," Baarn, it shall maintain a culture station and take up the work now done for us as a matter of grace by the Imperial Mycological Institute, Imperial Entomological Bureau and similar bodies in Europe. As these are not maintained for the benefit of the Indian workers and as they are very busy bodies. it takes months and even years may pass by before a report on any material sent to them, is received. If such a Bureau is established it will save much valuable time and money for India. Perhaps many workers in India are not aware of the fact that India contributes towards the maintenance of many of those bodies, and the subsidy already paid or promised by the I.A.R.C. to them exceeds Rs. 2,75,000. It may be a privilege to be associated with those bodies with such high reputation, but one has unfortunately to admit that the money we spend is certainly not commensurate with the benefit derived by India. If the amount had been spent in establishing such an Institute in India, it would have been of lasting benefit to her. I would strongly suggest that the Imperial Agricultural Research Council should immediately form a sub-committee to go into the matter and advise the Council regarding the details of the scheme. Such an Institute will no doubt have financial support from Provincial Governments as well."

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In commemoration of the Seventieth Birthday of Sir P. C. Ray, the Founder, the Foundation-President and a Patron of the Indian Chemical Society, a Jubilee Volume is being published by the Society, containing contributions from many eminent chemists in India and abroad.

The volume will cover about 350 pages. Price for Fellows Rs. 3, and for Non-Fellows Rs. 5.

The order for supply of the volume to be sent to the Hony. Secretary, Indian Chemical Society, P.O. Box 10857, Calcutta.

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Under the auspices of the Society of Biological Chemists, India. Mr. M. J. Narasimhan, Mycologist to the Government of Mysore, read a paper on "Cytoplasmic Inclusions in Spike Disease of Sandal" on 2nd November 1932. The transmissibility of the spike disease of sandal by grafting or budding is at present the only evidence for claiming that it is of the nature of a virus disease. In the tissues of spiked sandal were observed intra-cellular inclusions in close association with the nucleii similar to those reported in some of the plant virus diseases such as the mosaic disease of tobacco, the rosette of wheat, and the fiji of sugarcane and in some of the animal virus diseases such as rabies, and fowlpox. Particularly interesting was the fact that the inclusions in spiked sandal reacted to the same staining reaction that was claimed by Goodpasture, to be characteristic of the inclusions of fowlpox. The nature of the inclusions was also discussed. The presence of cytoplasmic inclusions in spiked sandal is a definite evidence of the virus nature of the sandal spike disease.

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At the ordinary monthly meeting of the Asiatic Society of Bengal held on the 7th November the following papers were read:—

1. DR. S. L. HORA.—*Buchanan's Ichthyological Manuscript entitled Piscium Bengalæ Inferioris Delineationes.*

Dr. Hora described a hitherto unknown Manuscript by Dr. Francis Buchanan, entitled Piscium Bengalæ Inferioris Delineationes Septuaginto octo, presented to the Asiatic Society of Bengal by Mr. Gilbert P. Whitley, Ichthyologist at the Australian Museum.

After stating Buchanan's early interest in the fishes of the Ganges and the interruption of his investigations, further particulars concerning Buchanan's fish drawings were given. A list of species with vernacular names and references to published accounts in the 'Gangetic Fishes,' was also presented.

2. DR. S. L. HORA AND D. D. MUKERJI.—*Further Notes on Hamiltan-Buchanan's Cyprinus Chagunio.*

It is well known that at the time of his departure from India in 1815, Buchanan was deprived of the drawings of fishes made during the Survey period at the Government's expense. Consequently, some of his species that are not illustrated in the 'Gangetic Fishes' are loosely defined and are difficult to determine. *Cyprinus chagunio* is a species of this nature. Considerable controversy raged between Gunther Day regarding the specific validity of this species. The precise systematic position of *C. chagunio* was indicated

by one of the authors in 1928, and it was pointed out that *Barbus beavani* Gunther had to be relegated to the synonymy of *B. chagunio*. Messrs. G. E. Shaw and E. O. Shebbeare's collection from the rivers of Northern Bengal has shown that *B. spilopholus* McClelland, a species characterised by the prolongation of the posterior rays of the anal fin and by the well-marked tubercular pads on the head, represents the males of *Barbus chagunio*. It is now clear that both *B. beavani* and *B. spilopholus* are synonyms of *B. chagunio*. A few remarks were made on the Sex Ratio in this species.

3. B. SAHNI AND A. R. RAO.—*On Some Jurassic Plants from the Rajmahal Hills.*

The paper dealt with collections made by parties from the Lucknow University during the years 1927, 1931 and 1932. The fossils described come from eight different localities, all in northern part of the Rajmahal Hills.

Several of the fossils belong to new species, but as some of them are only small fragments, names have been assigned only to three. The known species are only described or figured in so far as our specimens extend our previous knowledge.

A description of the localities with table showing distribution of species, Equisetales, Filicales, Cycadophyata, Coniferales, Incertæ, was given.

4. V. NARAYANASWAMI.—*Additional information concerning the Provenance of the Plants constituting the Malayan Collections of Sir George King, Hermann Kunstler, Father Benedetto Scortechini and Leonard Wray, being a Supplement to Sir George King's 'Materials for a Flora of the Malayan Peninsula' and Mr. H. N. Ridley's 'Flora of the Malayan Peninsula'.*

If Mr. Ridley's 'Flora of the Malayan Peninsula', published in five volumes between 1922 and 1925, be examined, it will be seen that a great many of the species described from materials laying in the Calcutta Herbarium are imperfectly localised. Nor were the exact localities given of the plants described by Sir George King and his helpers in the 'Materials for a Flora of the Malayan Peninsula'. Yet in regard to rare plants, exact localities are necessary and, to meet the need, the author has drawn up this compilation at the suggestion of Mr. I. H. Burkill, at one time of the Asiatic Society of Bengal, and afterwards Director of the Botanical Garden at Singapore.

After the papers were read DR. JOHAN VAN MANEN made a communication on *A new translation of the Gita Govinda.* Dr. B. Faddegon, Professor of Sanskrit in the University of Amsterdam, well known on account of his elaborate monograph on the Vaicesika-system, has published a translation of the *Gita Govinda* in Dutch. The translation is of considerable scholarly as well as poetical interest. A thoughtful introduction suggests some valuable explanations with the help of the psycho-analytic method.

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We acknowledge with thanks the receipt of the following:—

"Nature," Vol. 130, Nos. 3285–3288.

"Chemical Age," Vol. 27, Nos. 694–697.

Report of the Zoological Survey of India for 1929-32.

"The Indian Forester," Vol. 58, No. 11, Nov. 1932.

"The Journal of the Indian Mathematical Society," Vol. 19, No. 10.

"Journal of the Bombay Natural History Society," Vol. 36, No. 1, November 1932.

"Scientific Notes of the Indian Meteorological Department."

Reviews.

GEOFYSISKE PUBLIKASJONER, Vol. IX, No. 9. *Exploration de quelques perturbations atmospheriques a l'aide de sondages rapproches dans le temps.* By J. Bjerknes (Oslo: Det Norske Videnkaps-Akademi, 1932.)

Dr. J. Bjerknes' recent memoir on the investigation of some European atmospheric disturbances with the aid of successive soundings of the atmosphere carried out from Uccle in Belgium will doubtless rank as a classic of meteorological literature. The study is based on two sets of registering balloon ascents, the first set comprising 25 soundings in the period 26, 27 and 28th December 1928, and the second 7 soundings on 29–30th March of the same year. The soundings were made under the direction of Mons. Jaumotte, Director of the Royal Meteorological Institute of Belgium with instruments devised by him, and many of the balloons penetrated well up into the stratosphere.

The idea that "weather" is caused by perturbations of the atmosphere involving large-scale movements of air masses with a meridional component of motion and the consequent coming together of "air-masses" with differing temperatures and moisture-contents is no doubt old, but at the present day it has acquired a new definiteness and precision, thanks largely to the work of the Norwegian school of meteorologists. The feature of distinction of the present study from previous studies on the same subject lies in the greater fullness with which the properties of "air-masses" and of the associated "fronts" are followed out not only at the surface, but also in the free atmosphere up to the tropopause. Many points of detail about temperature and humidity distribution in height, which were hitherto either matters of theory or only supported by scattered observations, are now brought out lucidly and in a connected manner

with a definite individual series of disturbances.

The first of the series of ascents treated in this memoir reveals the story of a primary cyclone which moved in an approximately west-to-east direction across Scandinavia on the 26th December and of a secondary cyclone which followed it across Belgium on the 28th. Dr. Bjerknes shows that the whole sequence of phenomena was due to the eastward movement of a tongue of "cold" or "polar" air-mass whose maximum thickness over Uccle reached 5 km. and whose horizontal west-to-east extension was about 2000 km. The vertical section of the advancing and receding sides of the cold air-mass have shapes suggestive of the head and tail of the longitudinal section of an ærofoil. An interesting explanation is given of the continuous precipitation which occurred at Uccle before the arrival of the advancing or "aggressive cold wedge" as being due to the generation of a vortex of warm air in front of the advancing cold air, thus forming an obstacle for the rest of the inflowing warm moist air. This explanation is supported by the lines of flow of air which he has drawn identifying them with lines of equal entropy. As far as the writer is aware, this is the first occasion when isentropics, based on observation, have been presented in connection with a definite atmospheric disturbance.

Dr. Bjerknes has also shown that although the maximum thickness of cold air was only 5 km. over Uccle, further north-east, it extended right up to the tropopause.

It is well known that the height and temperature of the tropopause vary normally from about 17 km. and —80°C over the equator to 8 km. and —50°C over a latitude of 75°. These values are only average, and there are considerable day-to-day variations which are much more marked in temperate than in tropical latitudes. As a result of statistical studies, notably by Schedler in Germany, it had been established that a rise of the tropopause in temperate latitudes corresponded to conditions more tropical than those normal to the latitudes while a fall of the tropopause represented more polar conditions. Dr. Bjerknes has now shown that this result is true not only as an average but is also true of changes connected with individual cyclones. Similarly, the high positive correlation between the height of the tropopause and the pressure at 9 km. which had been established statistically by Dines is shown to be true of individual disturbances Dr. Bjerknes has also pointed out the clos physical connection between the perturba tions of the tropopause and those that occu in the lower layers of the atmosphere.

It is not possible, in a short review, t summarise the many new points of view, o the old points of view presented in a mor illuminating manner contained in this me moir. The thanks of all students of th Physics of the Atmosphere are due to Dr Bjerknes for this classical piece of work an to Mons. Jaumotte for the series of sound ings which made it possible.

K. R. RAMANATHAN.

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A Naturalist in the Guiana Forest. B Major R. W. G. Hingston. 16 plates and 15 illustrations. 18*s*. net. (Edward Arnold & Co., London, 1932.)

Here is a fascinating story of a teemin and fantastic insect world in which camou flage and mimicry, as protective devices, ar practised with an artistry seemingly beyon even the most adroit efforts of man. Majo Hingston opens up a world stranger tha any yet revealed in fiction, the marvels o which are told with the skill of a Fabre Here you may read of the association o spiders into a community and of thei association with ants: the spiders construct ing communal hammocks—one come upo was as tall as a man and able to hold a chil —in which ants build their nests, with egg larvæ and pupæ complete. These ants, i return for the hammock-accommodatior protect the spiders by taking a vigorou offensive when the hammock is disturbe and the spiders escape to safety.

You may also read of butterflies wit false heads; of caterpillars which mimi snakes and are provided with poison spines of a certain species of *Laternaria* whos heads are prolonged into a thick shovel shaped beak on which are modelled th features of an alligator; and of Cicada which squirt with force a fluid at the enemies. Again, you may read of ant which make bridges by linking themselve to each other; of termites on foragin expeditions; and of a battle royal betwee ants and termites.

This book is a narrative of the experience and observation of the expedition, of whic Major Hingston (whose biological work i India is so well known) was the leade organized and despatched to British Guian by the Oxford University Exploration Clu

three years ago. Its purpose was to study the fauna and flora of the equatorial rain-forest, but its main objective was to learn something of the teeming life in the forest roof, a dense green canopy through which sun and rain can hardly penetrate.

The book is in two parts. Part I describes in detail the life and doings of the expedition, and contains information concerning a number of practical matters which may be of use to any future party following the trail blazed by Major Hingston and the members of the expedition. Part II is devoted to records of detailed observations made in a forest described as "remarkably luxuriant, fully equal to that of the Amazon, and exceeding in splendour the Asiatic forests, where the great trees are taller, the tangle of bush-ropes more profuse and spectacular, and the crowding of epiphytes on the stems and branches more riotous in their diversity and confusion." *A Naturalist in British Guiana* certainly takes its place with the other classics of biological exploration and observation, and will be eagerly read by those whose interests in biology extend beyond the limits of laboratory study.

H.E.R.

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Tables of Cubic Crystal Structures of Elements and Compounds. By I. E. Knaggs, Ph.D. & B. Karlik, Ph.D. (Adam Hilger, Ltd., London.)

It is now almost axiomatic that X-rays serve as a powerful weapon in the study of Crystal Structure. In addition to the pioneer work of the Braggs, so much literature has accumulated on the subject of X-ray crystallography within the last twenty years that "the average researcher," says Sir William Bragg in his foreword, "will no doubt feel some satisfaction in realizing that long searches by many workers have been rolled into one, and that they (the authors) have earned the gratitude of those whose labour they have saved."

In addition to the principal data for a large number of crystals, a very extensive list of references—complete up to August 1931—is added. The usefulness of this work in this field can hardly be overestimated. "Crystal Structures in order of spacing" is the heading of another list which the authors claim to be immensely useful with the "Hilger Crystallograph" and interpretative chart.

Dr. C. F. Elam, the metallurgical specialist, has further enhanced the value of this book by contributing a corresponding set of tables dealing with alloys.

P.S.

Coming Events.

Indian Science Congress.

20TH SESSION.

Patna, 2nd—7th January, 1933.

Society of Biological Chemists (India).

2ND ANNUAL BUSINESS MEETING.

Government Medical College, Patna, 3rd January, 1933 (2-30 P.M.).

University of Madras.

EXTENSION LECTURES.

5th January 1933.
"Ancient South Indian Policy and its bearing on our Present Problems", by Dr. S. Krishnaswami Iyengar, M.A., Ph.D.

12th January 1933.
"Trade Union Movement in India", by Mr. P. S. Loganathan.

19th January 1933.
"Agricultural Improvement in Madras", by Mr. S. V. Ramamurti, I.C.S.

26th January 1933.
"Co-operative Movement in the Madras Presidency—Its Achievements and Failures", by Mr. D. N. Strathie, I.C.S.

30th January 1933.
"Poor Relief in Other Lands", by Miss T. Joseph.

6th February 1933.
"The Problem of the Indian States", by Mr. M. Ramachandra Rao.

10th February 1933.
"Federal Finance, the Main Problem", by Dr. P. J. Thomas, M.A., Ph.D.

13th February 1933.
"The Emergence of the State", by Mr. M. Rathnaswami, C.I.E.

17th February 1933.
"Disarmament", by Mr. J. Franco.

20th February 1933.
"Political Economy was the States' Master in the Nineteenth Century, while in the Twentieth it became its Slave", by Fr. Bassenach.

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CONTENTS.

Co-operation in Scientific Research.

ONE of the principal features of the recent development of higher education in India is the provision of facilities for scientific research in all the universities, and it is gratifying that the total annual output of work from their laboratories is increasing in volume and improving in quality. We have, at present, one university for every twenty millions of people and for every hundred thousand square miles. Judging merely from the geographical area of India and the density of her population, few will maintain that our eighteen or nineteen universities are excessive. We are rather disposed to think that in South India alone there is room for at least three more universities. It has now become part of the political doctrine of enlightened Indian public opinion that a wider diffusion of higher university education is indispensable to national progress.

Some well-meaning critics still hold that these centres of research and learning are directly responsible for the growth of unemployment in the cities, and propose that the funds now granted to universities should be diverted to the more useful and urgent purpose of spreading elementary and secondary education among the people. The disparagement of higher education by these popular representatives is probably due also to a vague apprehension that the money spent on the university benefits only a few, these few do not contribute directly to the earning power of the nation and the man who pays for them receives hardly any return for his money. We are afraid that this mode of reasoning can only be considered as a sample of the logic of democratic enthusiasm.

Furthermore, there is a class of reformers of Indian universities who advocate their conversion into technological and commercial institutions where young men undergoing practical training will be put in a position to earn their living and to contribute to the material prosperity of the society to which they belong. It is true that if universities are established in manufacturing centres, their technological sides will help to foster the local industries and may even help to maintain their supremacy; but it scarcely occurs to these zealous reformers that all universities are incapable of such transformation without prejudice to their more legitimate function. If a young man is destined for an industrial or business

career, it is in the workshop and the office of industrial institutions that he will learn his lessons more profitably than in the class rooms of the university. The village smithy, the local carpenter's table and the cottage handlooms provide really a more profitable training to the future rural industrialist than can be imparted in any secondary school. The fact is that all these adverse criticisms of the existing institutions are a product of an inverted snobbery.

Till recently the history of our universities has been one of routine and examinations and the colleges coming under their influence were naturally pre-occupied with fostering a kind of education devised to satisfy the rather arbitrary demands of public examinations, almost to the neglect of the equally important part of their function of promoting independent enquiry and freedom of thought. Where a system of external examinations is permitted to dominate the education of an affiliated institution, the latter tends to become mechanised and the products of such education will also tend to conform to an inelastic type, scarcely possessing a well-differentiated individual intellectual trait. In the universities in which there is abundance of good education and less examination, the result has always been a beneficial stimulation of post-graduate work in the laboratories and diminished numbers of bookworms, intellectual idlers and irresponsible critics in the country.

None of the numerous witnesses who deposed their evidence before the Sadler Committee has praised the system of university education, or upheld the unscientific method of examination then in existence; and almost every one attributes to these two causes the lack of an adequate output of work from research laboratories. It seems to us that a radical reform of the syllabuses of study for the various degree courses and a more humane scheme of examinations are urgently called for and that this desirable end can be secured only through the increasing exertions of the Inter-University Board. The general experience of the professors is that the intellectual curiosity of some of the brilliant young men, if it escapes the freezing influence of examinations, is in danger of being stifled by their poverty and naturally they proceed to seek employment under government rather than stay in the university to take up a piece of original work. For the purpose of increasing the output of original investigation from Indian universities, we would repeat and emphasize the well-known suggestions about a generous and stable financial scheme of research fellowships and post-graduate studentships which not merely attract and retain some of the ablest research workers in the universities but also provide for periodical encouragement by way of increments to their emoluments, the establishment of a number of endowed research chairs, financial provision for scientific expeditions other than official and the release of professors from routine which in the existing conditions gives them little time and less inclination for laboratory work. The public mind of India is steadily recognizing the value of scientific work and it is hoped that before long the wealthy section of the community will come forward with munificent donations for the creation of a network of research centres all over the country.

In the meantime the scientific investigations now being conducted in the different universities, in aided research centres, official scientific departments and laboratories maintained by private industrial organizations, can be strengthened and the rate of their progress accelerated through a definite scheme of co-operation and an agreed plan of work. At present the Indian Science Congress follows rather too closely the practice of the British Association for the Advancement of Science, in providing a forum for the reading of papers at the sectional meetings, in organizing public lectures on scientific subjects and joint meetings of sections for discussion of topics of common interest. There is, however, no provision in the Congress organization for directly promoting the advancement of science in India and its relation with the universities is not even formal. Its influence, therefore, on the general progress of scientific investigations is indirect and in the nature of things, quite remote. Separated by great distances, the workers in different centres of research might select and investigate almost identical problems and discover after the completion of their research that they have been anticipated, one by the other.

This avoidable and unnecessary duplication of work can be prevented if the delegates attending the Congress would meet and discuss the facilities afforded by their research laboratories for special work in the different branches of pure or applied science and the problems in which their colleagues,

their research scholars and themselves are most interested. The paths of allied sciences cross each other in many ways and the joint meetings of the sections might be devoted to a careful consideration and selection of the problems and their assignment to different research centres by common understanding. At the annual session of the Congress there would be, under such a scheme, presentation of completed papers or preliminary communications of results on known subjects. Besides preventing duplication, men of science will be aware of the nature of work progressing in different research centres and will be able to obtain such information or assistance as they may require from those departments likely to provide them. Without unduly curtailing the freedom of the researcher, a definite policy such as this will ensure for every paper, that is read before the sectional meeting, a most complete and illuminating discussion. It is absolutely impossible to read and discuss fully all the hundred and fifty pieces of research now submitted to sectional meetings within the twelve hours at their disposal and consequently the scientific message of a large number of papers is practically forced to remain subconscious.

Perhaps one effect of the plan of carrying on work on a co-operative basis may be diminution in the number of papers. Though this is to be regretted it is hoped that the lack of quantity will be more than compensated for by the quality and the fruitful results of a complete discussion and free exchange of thoughts.

One other advantage that will result from a programme of the type outlined above will be the recognition of different centres as being associated with definite lines of research. Such places will also be recognized as centres for disseminating reliable and accurate information in those and related branches of science. Thus will spring up a series of *information bureaux* which will assist not only fellow-scientists with relevant literature and other technical information but also other members of the public interested in the utilization of such knowledge. In view of the bewildering increase in scientific literature during recent years and the inadequate library facilities at many of the research centres in the country, the importance of such an organization can hardly be over-estimated.

It seems to us that a federation of research centres under the moral countenance of the Indian Science Congress, directed on the principle of effective and cheerful co-operation, will produce results in the future in an increased measure and quite as brilliant as those that already stand to the credit of most Indian universities. The main idea is that a professor working on a problem should have the means of assuring himself that it is not also simultaneously engaging the attention of another professor in some other Indian university and that the schools of research into which the universities have already become differentiated should be more widely and practically recognized. Moreover, every research worker should have the fullest possibility of receiving information and assistance whenever he requires them. Under existing conditions, in which investigation is conducted in almost water-tight compartments, progress must necessarily be slow though a few have succeeded in accomplishing international distinction. But this is not enough to build up an Indian scientific reputation and tradition quite as honourable and enduring as those of any of the European countries. The intent of co-operative research must be to mobilize the intellectual resources of the country for the achievement of common ends. Apart from the Asiatic Society of Bengal and the Bombay Natural History Society, there are no institutes of science and learned societies such as occur in European countries, on an all-India basis and there are no all-India scientific journals for the publication of original papers in different branches of science. The existence of such national institutions is calculated to provide additional stimulus to greater endeavour than now and the possibilities of founding them would be a fit subject of examination by the Indian Science Congress.

The ideal of co-operative research is selflessness and self-sacrifice, without limiting opportunities of adding to one's individual reputation. If we assume that the tradition of a country is the history of its achievements made possible by common endeavour, then we are still a long way from establishing one for India. Suppose that it becomes feasible to establish a federation of research centres in India, the scientists concurring in a coordinate effort to lay the foundation of a new tradition, the furtherance of this object can only be secured by the institution of more than one all-India scientific journal for recording the total output of work produced in different branches of science

within her boundaries and by preservation of them in her archives. The question of international publicity and priority of announcement of discoveries, so essential for Indian science, need not necessarily present insuperable difficulties. The former is secured by the determination on the part of all the scientists working in the country to publish all their best results in India and the latter is most effectively secured through the facilities already available for them through *Current Science*. We have not the slightest hesitation in thinking that the greatest ideal of all the leading men of science in India is not so much to achieve personal triumphs as to dedicate their services for common interests, ideals and traditions. Given the right spirit and incentive to high endeavour, it would not be fantastic to suppose that before the next quarter of a century elapses the new generation of scientists in India will move for the grant of charter for the establishment of a Royal Society and in this task the present generation will have to pull together as pioneers. To the Indian Science Congress one must naturally look for the birth of great ideas and we are of opinion that the time has arrived for this representative unofficial body to conceive a nation-wide scheme of constructive programme of scientific work.

The growth of industries and commerce and urban life has already established an intimate liaison between their problems and those of science; and the next generation will emphasize this relationship even more strongly. The official research departments can no longer function independently of the universities which in their ultimate scope will be found to possess a common purpose. The problems of agriculture and forestry really belong to more than one branch of science and it is here that co-operative research may prove of great importance. The Indian Institute of Science should be more widely utilized by the universities and official departments than now for the advancement of the material prosperity of the country. The Imperial Council of Agricultural Research through a scheme of grants for research in applied and pure science, has already taken steps to enlist the co-operation of the universities with the laboratories of the official departments, and similarly the Indian Medical Research Fund Association is functioning in close co-operation with the Department of Public Health and other research institutions of medical science.

Unless the efforts of all these research centres converge towards a common ideal, the mass advancement of science itself must for some time remain a dream in India. It must be pointed out that the co-operative research that we suggest will neither hinder nor eliminate the opportunities for individuals engaging in special fields of enquiry. We are aware that an investigator starting to solve a problem in accordance with the principles of our scheme, may discover in the course of his work other ideas which will take him away from the original problem. This is decidedly an advantage to the scheme itself. There is no intention to put obstacles on the freedom of the research departments or to apply rigid rules to their methods of work by the advocacy of co-operative research.

The doctrine that, "neither science nor the people would lose much if no attempt ever was made to bring them together", should not commend itself to the local self-governing institutions whose problems need the aid of science in every detail and particular. Science indeed loses its entire significance if it does not establish an intimate contact with the vital forces of civic administration. In modern life it is becoming increasingly clear that science and society must collaborate for the fullness and enrichment of both, and science is deprived of none of its dignity by being associated with the problems of every-day life. The introduction of fast moving vehicles in India without a previous preparation of the road conditions in the cities has been the cause of certain wide-spread diseases of the throat and the eye from which, as the Reports of the Medical Inspection of schools and colleges have abundantly shown, a large majority of the school-going population is suffering. Traffic in the cities has become positively dangerous. The disposal of town refuse or its utilization is essentially a scientific problem. Town-planning, the distribution of wholesome water, the drainage system, the supply and control of unadulterated food-stuffs, the protection of people against outbreak of epidemics, the preparation and interpretation of vital statistics and a number of other municipal problems require the effective assistance of scientific research for their solution. The municipalities ought to take the fullest advantage of the universities and the Indian

Science Congress to which they should present their own local problems for investigation. In order to widen the scope of the usefulness of the Science Congress it may be deemed desirable to admit within its province the problems of municipal administration which directly concern the health and efficiency of the people.

Under the reformed constitution Indian scientists will be confronted with tremendous problems, and their preparedness to grapple with them on the basis of a common purpose and common understanding, must in a measure constitute the vindication of the general demand for the freedom of the country to progress.

Announcement.

WE have pleasure in informing our numerous readers that Sir Richard Gregory, Editor of *Nature*, will arrive in Bombay on or about January 19th. 1933, by the P. & O. SS. *Mongolia* and will be in India for about a month. He will be accompanied by Lady Gregory and hopes to visit Allahabad, Calcutta, Madras and Bangalore during his short stay in the country. Any communications intended to reach him on arrival should be addressed to Messrs. Macmillan & Co., Ltd., 276, Hornby Road, Bombay, and afterwards to their branches at Calcutta and Madras. We welcome Sir Richard A. Gregory and Lady Gregory to our country.

Effects of Temperature on the Determination of Size of Species.

By Dr. C. C. John, M.A., D.SC., D.I.C.

GRAY (1931) by his experiments on the eggs of *Salmo fario* has shown that the size of the embryo at the end of larval life is smaller at a higher temperature than at a lower. For the eggs of any given species of animals there exists a range of temperature within which the embryo is capable of developing into a normal healthy individual. If the temperature of incubation is raised, the rate of development of a cold-blooded embryo is increased and if the temperature is lowered the rate of development is retarded. Though the rate of growth at a higher temperature is more rapid, the final size at the end of larval life is smaller at a higher temperature than at a lower. This is because a larger proportion of yolk is required for the maintenance of the embryonic tissue at a higher temperature and only a smaller proportion is available for the formation of new tissue. Each of the many processes accompanying development is altered and a "new state of dynamic equilibrium is established" with the increase in temperature. These facts can be extended to a consideration of the development under natural conditions. The temperature of the seas increases as we proceed from the polar to the equatorial regions, so that the larvæ which develop under these different conditions are bound to show differences in size and the same conclusions may be applied to the adults also which develop from these larvæ. If this could be proved it means that individuals of any given species of aquatic animals (invertebrates and cold-blooded vertebrates) living under colder conditions will be larger than individuals of the same species in warmer seas.

The genus Sagitta is well suited for the verification of this fact, because of its occurrence in all the seas of the world under all conditions of temperature and depth, from the Arctic and Antarctic to the Equatorial seas. In a general consideration of the distribution of Sagitta the most disturbing factor is the difference in length of the specimens of any particular species obtained from different localities. For instance *S. enflata** obtained from San Diego region (Michæl, 1911) are about 15–21 mm., whereas the specimens collected at Madras are only about 11·5–13 mm. The same kind of difference is also noticed in *S. neglecta*. In fact all the species found to occur both in tropical and temperate seas show differences in length, the tropical form being always smaller in length, compared to those obtained from temperate seas.

There are some species such as *S. lyra*, *S. hæmata*, *S. macrocephala*, *S. elegans* and

* The Sagitta of the Madras coast have been wrongly identified as *S. bipunctata* (Shankara Menon, 1931). I was kindly permitted to re-identify the material and have been able to describe five species *S. enflata*, *S. gardineri*, *S. tenuis*, *S. neglecta* and *S. robusta*. Probably a few more species may be discovered by more systematic method of collection.

S. decipiens, which have been so far recorded only from cold water regions under conditions of temperature varying from 1·1° to 18·6°. Among these *S. lyra* has a total length of 18–48 mm. while the length of *S. elegans* is 21–23 mm. In comparison with these there are some species, which are restricted to the warmer seas (temperature, 21–29°), such as *S. neglecta*, *S. regularis*, *S. betodi*, *S. ferox*, *S. tenuis*, *S. gazelle*, *S. hispida* and *S. pacifica*. All these species are relatively shorter, for example, *S. neglecta* measures about 8–13 mm., *S. tenuis* 5–5·5 mm. and *S. hispida* 5·5–10 mm. Though all the species mentioned above are limited in their range of distribution there are quite a number of others, which show a cosmopolitan distribution, *e.g.*, *S. bipunctata*, *S. hexaptera*, *S. subtilis*, and *S. serratodentata*. *S. hexaptera* has been recorded between 70° N. and 40° S. at temperatures varying from 6° to 29° and *S. bipunctata* between 74° N. and 28° S. at temperatures varying from 0·2° to 34°. Among these two, *S. hexaptera*, especially, gives the best example of the influence of temperature on the determination of the size. The total length of *S. hexaptera* varies from 20–70 mm. Specimens obtained from the Gulf of Naples are about 20–25 mm. long while those obtained from colder regions are considerably longer, reaching upto 70 mm. in length. I was privileged to examine the collection of Sagitta of the "Discovery" expedition and the first thing which impressed me about the whole collection was the comparatively larger size of the specimens. Samples of *S. hexaptera* in this collection measure about 70–80 mm. These large specimens were obtained from regions beyond 40° S. and at depths ranging from 1,800–3,000 metres. The surface temperature in these regions varies from 8°–12°, but temperature at the depth from which these specimens were obtained is very much lower.

Though the data available at present are not sufficient for drawing up a statistical table, the general facts seem to indicate that in the colder regions Sagitta are comparatively long and that increase in temperature is accompanied by a corresponding reduction in size, in other words, the length of any given species of Sagitta in relation to its distribution is inversely proportional to the temperature of the locality from which the specimens are obtained.

For a study of the length of species in relation to temperature more than one factor is to be taken into account. Apart from its surface distribution Sagitta occurs at various lower depths, so that unless the depth of the catch and the temperature of that depth are definitely known it will be difficult to estimate the true relationship between temperature and size. If temperature does really influence the length of the species, then bathymetrical distribution is an important factor. It is one of the simple facts of Oceanography that temperature diminishes with depth, the bottom being always very much colder than the surface. Therefore, if in any locality a species of Sagitta shows vertical distribution the length of individuals obtained from markedly different depths are bound to show differences in length. But very careful systematic study of both Geographical and Bathymetrical distribution are essential before these facts can be definitely established.

Differences in the length of the larvæ may also be noticed in some aquatic forms of the temperate regions which produce two broods in the year. This is clearly seen in Herring (*Clupea harengus*) the common food fish of Europe. The Herring produces two broods, the autumn brood and the spring brood. The eggs of Herring are demersal, *i.e.*, they are laid at the bottom of the sea. They are hatched on the seventh day and the larvæ keep to the bottom for about three or four days till the yolk in the yolk sac is completely absorbed. The larvæ of the spring brood now migrate vertically upwards to the surface and from there to the coast, while the autumn brood behaves in a slightly different way. They never appear to leave the bottom but migrate shorewards without an intermediate journey through midwater. When the larvæ reach the shore the two broods are of different lengths, so that it is difficult to estimate age in relation to length, but it can be shown that at the stage when red blood appears some of the specimens are about 33 mm. and others 35 mm. long. (John, 1932.) This stage has been called the metamorphosing stage. If it is taken for granted that at the time of metamorphosis all the larvæ are of the same age the difference in length can be explained only by the difference in the temperature of the sea water in which the two broods pass their early development. The spring brood undergoes its earlier development through summer while the autumn brood passes this stage through winter.

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Agricultural Meteorology.

By Dr. L. A. Ramadas, D.Sc., *Agricultural Meteorologist, Poona.*

THAT weather has a great influence on crops is well known from the earliest times. The farmer has ever watched the skies anxiously for symptoms of coming weather for guidance in planning and prosecuting his farming operations. The experience of past ages has crystallised into popular weather lore handed down from generation to generation; but such information is necessarily empirical and of very local interest. As Sir Napier Shaw said in his opening address on Agricultural Meteorology before the Conference of Empire Meteorologists, Agricultural Section, 1929 (London), "Agricultural Meteorology is what the farmer knows and won't (or can't?) say". With the development of Agriculture and Meteorology as more and more exact sciences in recent times, we feel the need to-day of escaping from the limitations imposed by the vagaries of weather on farming and of exploiting with fore-knowledge the results of modern science in artificially improving the growth and yield of crops, in combating the adverse effects of fungi and pests and in protecting crops as far as possible from damage by bad weather either by inventing protective devices or by culturing weather-resisting types. It is the business of the Agricultural Meteorologist not merely to discover exactly "how much sun, how much warmth, how much rain was necessary for a bumper crop" but also to find out whether he can tell the farmer before-hand how much of these elements of weather he may expect in a given season. The State is also an interested party as it wishes to know before-hand, however roughly it may be, what the prospects of agriculture are likely to be and how much land revenue may be expected during a financial year.

Russia was one of the earliest countries to move in this direction and systematic observations of meteorological elements side by side with the growth and yield of different crops were commenced at a large number of experimental stations (the number of stations was 81 in 1912). The United States of America, Canada, Great Britain and most of the European countries have similar organizations for the study of Agricultural Meteorology and its practical applications to farming. The growing interest in the applications of meteorology to agriculture is also shown by the fact that before the War the International Meteorological Committee appointed a special Committee to study meteorology in relation to Agriculture. This Committee is now under the Chairmanship of Dr. Wallen of the Swedish Meteorological Service.

In India the Meteorological Department was instituted in 1875 to combine and extend the work of various provincial meteorological services which had sprung up before that date. The warnings to ships, ports, aeroplanes, etc., the daily weather reports, the monthly weather reports and seasonal forecasts for rainfall issued by the department are based on meteorological observations received by the forecasting centres from about 200 surface observatories. The observations recorded daily at these and a few more observatories for periods ranging upto 50 to 60 years are now available. The Department has also been responsible for technical supervision of rainfall registration at about 3000 stations in India, so that, on the meteorological side, there is available at present a very large mass of accumulated data for correlation with available crop data.

It will be recalled that two years ago, soon after his return from Europe after attending the International Meteorological Conference at Copenhagen and the Conference of Empire Meteorologists in London, at both of which Agricultural Meteorology was one of the subjects for discussion, C. W. B. Normand, Director-General of Observatories in India, placed before the Imperial Council of Agricultural Research a modest scheme on Agricultural Meteorology on the lines of the recommendations made by the Royal Commission on Agriculture in India (*vide* para 577 of their Report, 1928) so that India may fall into line with other nations which had already made a start. The scheme was sympathetically considered by the Council and official sanction was given early last year for giving effect to the scheme for a period of 5 years. Unfortunately the scheme had to be held up owing to the retrenchment campaign of the Government of India in 1931. The Government of India recently reviewed the research schemes sanctioned by the Imperial Council of Agricultural Research, and decided that rather than postpone the scheme of Agricultural Meteorology until the financial situation improves, it should be proceeded with on a reduced scale for a period of three years. The cost of the restricted scheme is roughly half of what was originally sanctioned. The New Branch began functioning in August last at the Meteorological Office, Poona.

The work of the new branch on Agricultural Meteorology will be under two heads: (*a*) Statistical, and (*b*) Experimental or Biological, but these two lines of enquiry are complementary to each other.

The programme of statistical investigation will begin with a critical enquiry of the available data on the area and yield of crops for the various presidencies and districts in India, and proceed, after careful selection, to correlate some of them with the accumulated meteorological data.

It will be one of the aims of the new branch to interpret the needs of the farmer to the weather forecaster and to tell the farmer in what way the

meteorologist could help him. There is no doubt that the daily weather telegrams which sometimes include 48 hours' warning of heavy rainfall and other phenomena may at certain seasons be of immense help to cultivators; but the problem is one really of the dissemination of this information with sufficient quickness so as to be useful to the recipients. This may require an elaborate and, for the present, impracticable organization involving the several departments as well as widespread W/T facilities in the country.

On the experimental or biological side there is a routine as well as a research aspect. In the routine work an essential preliminary will be to decide what meteorological and physical data ought to be collected regularly at all experimental farms for future correlation with the rate of growth and the yield of crops. The earlier investigations will also aim at the selection of the best methods and standardising them for the measurement of solar radiation, evaporation, soil temperature and soil humidity so that these data may ultimately be systematically maintained in addition to those of air temperature, air humidity, rainfall, wind, etc. The other problems will mainly be concerned with the meteorology of the air layers near the ground and the flow of heat and water through the surface of the ground. These investigations will enable one to understand the micro-climatology of different crops and to ascertain what fraction of the rain which falls from time to time at a place is actually available for crops (*i.e.*, the effective rainfall). Opportunities may also arise for joint work with Biologists and Mycologists, *e.g.*, on the effect of wind and evaporation, etc., on the plants, fungi, etc.

It is the intention of the new branch to seek the co-operation of various Agricultural Departments in order to arrange for detailed meteorological observations to be collected side by side with crop observations in at least a few experimental stations in most of the provinces. By close co-operation with the Agricultural College at Poona a model agricultural meteorological station is being evolved during the first year. This work will provide the basis for later extension of systematic experimental work on Agricultural Meteorology to a few selected experimental farms distributed over India. In this connection the need for careful standardisation of the meteorological instruments either already in use or to be used in different farms by comparing them with the standards of the Indian Meteorological Department can hardly be over-emphasized.

The programme before the new Branch of Agricultural Meteorology is indeed very formidable. The close co-operation of the various Agricultural Departments in discussing or studying problems of mutual interest will be invaluable to the Agricultural Meteorologist. With the scanty resources and staff now available it is recognized that the pioneer work of the new branch will be difficult; but the work done during the first three years will, it is hoped, prove to be the foundation of future systematic work on a scale more proportionate to the size of the country.

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CONTENTS

The Indian Science Congress.

NO excuse is needed for making this issue of *Current Science* a special Science Congress Number. This Congress has become, during the twenty years of its existence, the one common meeting ground for men interested in all branches of science from all parts of India, and its meetings consequently, events of outstanding interest to readers of this Journal. *Current Science*, moreover, though not officially connected with the Congress, was started as a result of a discussion held during its last year's meeting. It is thus closely associated in its origin with the Indian Science Congress, and as both are intended to serve the same body of persons it seems likely that this informal association may continue and prove to be of the benefit to both.

The early history of the Indian Science Congress is recorded in the Proceedings of its Fifteenth Meeting in the Presidential Address delivered that year by Dr. J. L. Simonsen who had been largely responsible for its inception and early management.

After some preliminary correspondence, a meeting of seventeen of the foremost men of science in the country was held in the rooms of the Asiatic Society of Bengal under the Chairmanship of Sir Henry Hayden. This meeting decided that "The Asiatic Society of Bengal be asked to undertake the Management of a Science Congress to be held annually." But it was not till January 1914, that the first meeting was held in Calcutta with Sir Ashutosh Mukherjee as President.

The attendance was promising, though we should regard it as very small to-day and the total number of papers read was only a fraction of the number now presented to several of the individual sections. As was not unnatural, moreover, of these thirty-one papers twenty-five were from authors resident in Calcutta or other places in Bengal, bringing out very clearly the need for special facilities to enable members from all parts of India to attend as nearly as possible with equal facility. With the aid of the Board of Scientific Advice (since abolished) the Government of India were therefore persuaded to issue orders that selected officers from the various provinces, who could be spared, might be permitted to attend the meetings on duty. This, however, did not help those who were not Government servants, and in

their interests most of the Indian Railway Companies granted concession rates for the meetings. It is unfortunate that of these special facilities the latter was withdrawn during the war and has never been renewed, while the former is now severely restricted owing to general financial conditions.

The first Calcutta meeting resolved "That the Asiatic Society of Bengal be requested to publish for the present an account of the proceedings of the Congress and of such of the papers read as might be agreed upon by the Congress Committee and the Secretaries of the Society." The Asiatic Society of Bengal, founded in 1784 by Sir William Jones to enquire into "whatever is performed by Man or produced by Nature" within "the geographical limits of Asia", being (in spite of its name) an All-India Society with traditions and organization built up through over a century of steady work, publishing a Journal of world-wide circulation and reputation, and having among its members an influential body of men of science, was probably the only society in the country that could in this way give to the newly started Science Congress just the help that was needed to ensure satisfactory development. As a consequence the appointment of the Science Congress Secretaries was at first made subject to confirmation by the Society's Council, the Society's Treasurer was asked to be and still remains *ex-officio* Treasurer of the Congress and the Society's General Secretary was appointed and still remains an *ex-officio* member of the Congress Executive Committee.

Thus started and assisted in its growth, the Science Congress rapidly developed and its proceedings became so bulky that those of the tenth meeting (1923), though issued by the Asiatic Society in the same size and style as before, were treated as a separate volume instead of being incorporated in the Proceedings of the Society; and in 1926 the finances of the Science Congress were entirely separated from those of the Society.

During all these years the constitution adopted after the first few years of development remained in force with a few slight modifications. During the seventeenth meeting (1930), however, a special discussion of the constitution was held to voice a growing body of opinion that the time had come for the framing of a new constitution to suit the altered circumstances that had arisen as a result of the rapid and healthy growth that had taken place since those early days. As a result a sub-committee was appointed to look into the whole matter, and a carefully revised constitution was finally adopted at the eighteenth meeting, held at Nagpur in 1931.

The Indian Science Congress has thus become a well-established organization. What has it accomplished in the past? What should be its aims to-day? And how can these be best achieved?

Persons interested in scientific problems have met together annually to listen to or read an immense number of papers of varying interest and this is about all that can be recorded in its Proceedings. Judged by its printed record alone we doubt if anyone could regard the meetings of the Science Congress as worth the time and energy spent over them by secretaries, committees and members who leave their work and often travel great distances to attend. But the printed record can describe only the dry bones and not the life of the meetings to the maintenance of which they are, nevertheless, essential. As pointed out by Lord Pentland in welcoming the second meeting of the Science Congress to Madras, "We are all aware that the value of such meetings as this does not lie wholly in formal meetings, and that the opportunities of intercourse are perhaps as valuable as the formal meetings of such a Congress. It must be a great encouragement to the workers in science as well as in other branches occasionally to meet and compare results, to get to know one another, to have the many advantages of personal and social intercourse which a few days together must bring to isolated workers in so large a field; especially in so large an area as is represented by the term India."

We are inclined to go still further and to regard such opportunities of intercourse as probably the most valuable function of the Science Congress. And Dr. Simonsen gives this as the main reason for its foundation, saying that when he and Prof. MacMahon first arrived in India "Coming as we did from large English laboratories, we at once felt the great lack of any scientific intercourse. Not only was there neither in Lucknow nor Madras any scientific society, but in addition there was a complete absence of any scientific atmosphere. At that time, if we except the Asiatic Society of Bengal, the only opportunities afforded for scientific discussion were the somewhat irregular conferences promoted by the Government of

India, such as Sanitary Conferences or Conferences of Agricultural Chemists. These were purely official gatherings, and it occurred to Prof. MacMahon and myself that scientific research might be stimulated if an annual meeting of workers somewhat on the lines of the British Association could be arranged. We felt that not only would the direct personal contact of workers be of great value, but also that the general public would be brought to realize the importance and value of scientific research."

That the Indian Science Congress has amply justified its existence by the opportunities it has provided for personal intercourse between scientific workers is clear. But that the curtailment imposed last year on the facilities hitherto granted by Government to its servants to attend the meetings is bound to have unfortunate results in regard to this is equally clear and calls for immediate and careful consideration. It seems to us that the least that Government can do is to permit such of its servants as can be spared to attend on duty at their own expense, as some Governments did last year, and to urge all Universities and other bodies employing scientific workers to do the same. But in a country of the size of India this alone will not solve the difficulty. The holding of the meetings at a time which permits of members attending availing themselves of the Christmas concessions granted to the public by the railways has proved a suitable alternative to the special concessions for the meetings that were in force for a short time earlier on. The Science Congress is now so well established and scientific workers so keen to benefit from its meetings that these arrangements would doubtless suffice to ensure a large attendance. But it would almost certainly be found, as at the first Calcutta meeting, that workers from the more distant parts of the country were far too few adequately to admit of the personal intercourse between workers from widely separated places that so particularly need promoting, or even to provide proper continuity of personnel between one meeting and the next.

Something is evidently needed to facilitate the attendance of distant members, especially such as have long experience of the Science Congress and have proved themselves of special value in connection with its meetings. How this can best be secured it is difficult to see. The grant of travelling allowance by Government to its servants was a great help and would reduce the problem to much smaller proportions if it could be restored. But even this is not a complete solution, for its help is confined to those who are Government servants. We feel that efforts should be made not only to secure the renewal of this privilege to Government servants but also to encourage the formation of a fund, probably by donations and legacies, from which the Congress would itself give similar assistance to those permanent members who do not hold this position, especially such as are office-bearers in the different sections.

We feel, further, that the reading of a paper is not in itself a sufficient reason, nor even the most important reason, for the granting of such assistance. Indeed, we have even heard it suggested that the multitude of papers received, in certain sections particularly, good enough in themselves but of so limited an interest as to be more of a hindrance than a help to the progress of the meeting, has been in no small measure the result of a belief among Government servants that unless they had a paper of some sort to read facilities for attending the Science Congress would not be granted. That the value of a particular person to the Congress meetings, or of the Congress meetings to his work, is not at all necessarily connected with the reading of a paper will, we hope, be recognized and always be borne in mind by those with whom the granting of facilities to particular persons rests.

The second object for which the Indian Science Congress was founded has unfortunately not been by any means so fully realized. Public lectures, it is true, form a regular feature of the meetings, but to judge from the audiences they seem to appeal more to the members of the Congress than to the general public. This is, perhaps, inevitable as things stand at present and may well be regarded as more the fault of the public than of the Congress, but it is none the less regrettable.

In at least one instance, the foundation of the Madras Fisheries Department Marine Biological Station on Krusadai Island in the Gulf of Manaar, Government action in the interest of scientific workers and students has been initiated as the direct result of action taken by two of the sections of the Congress jointly.

Lastly, is it too much to hope that *Current Science*, born at the last meeting

of the Congress, may be instrumental in spreading abroad its aspirations and achievements among other news of scientific interest, more widely than is likely to be directly possible through any printed proceedings of meetings?

Presidential Address.

By Dr. L. L. Fermor, O.B.E., D.SC., A.R.S.M., M.Inst.M.M., F.A.S.B., F.G.S.

I.—GENERAL.

To accept an invitation to preside over the Indian Science Congress is to accept a great honour, and I thank you gratefully, fellow-scientists, for this. But it is also to undertake a great responsibility, not the least portion of which is to deliver a Presidential Address at the commencement of the Session.

Before dealing with the special subject of my address, it seems desirable that I should first notice a few events and matters of interest or importance to scientists in India, including a reference to three of your Past-Presidents.

The first is Dr. Martin O. Forster, your President at the 12th Congress held in Benares in 1925. He is due to retire shortly from the responsible position of Director of the Indian Institute of Science at Bangalore, a post that he has held for over 10 years. As scientists, we thank him for the fruitful work he has done at Bangalore in supervising and stimulating the development of research; and as friends we wish him happiness and a further spell of usefulness on his return to England.

Dr. Forster is to be succeeded by Sir C. V. Raman, your President at the 16th Congress held at Madras in 1929. The high quality of Sir Chandrasekhara's work at the Indian Association for the Cultivation of Science in Calcutta and as Palit Professor of Physics at the University of Calcutta, and his inspiring leadership in the development of a school of workers in Physics, is a happy augury to the application at Bangalore of a further stimulus to scientific research at that southern centre. Calcutta's loss will be Bangalore's gain. At present Calcutta may be regarded as the centre of scientific research in India; but, with the transference to Bangalore of one of her leading investigators, she will have to guard her laurels.

The third Past-President I wish to mention is Lt.-Col. R. B. Seymour-Sewell, who is leaving India in April on leave preparatory to retirement from his post as Director of the Zoological Survey of India. We are not, however, at once to lose his services completely, for he has been appointed to lead the Sir John Murray Oceanographic Expedition to the Arabian Sea. Many of you are familiar with the results of the famous research expedition of H.M.S. *Challenger*, which, during the years 1873–76, explored the oceans of the world. The results of these researches are embodied in a monumental set of volumes issued over a period of nearly two decades under the editorship, first of Sir C. Wyville Thomson and later of Sir John Murray. The survey of the oceans was not, however, complete, the study of the Arabian Sea being omitted. Sir John Murray in his will left a sum of money for this survey, and now that it has been decided by his trustees to complete the task, they may be regarded as very fortunate in having been able to secure the services of Col. Sewell, with his wide experience of oceanographic research obtained as Surgeon-Naturalist to R.I.M. *Investigator*. We wish Col. Sewell every success in this new field of activity.

To one other scientist I must refer, namely, Sir Ronald Ross, who died at the age of 75 during the past year. You are all aware of his discovery of the method by which the parasite of malaria enters the human body, and of the enormous development in tropical medicine that has followed upon that epoch-making discovery. Ross' work was done in India and it has led to untold benefits to millions of inhabitants both of India and of other tropical countries. Sir Ronald left India before the foundation of our Congress, so that we have not had the privilege of his presiding over one of our gatherings. Nevertheless, we shall honour ourselves by recording our great loss in the death of one of the most distinguished scientists who has ever worked in India.

An event of major importance to the development of science in India during the past year was the decision made by a group of scientists during the last session of the Indian Science Congress at Bangalore to publish a scientific journal on the lines of

the well-known English weekly journal, *Nature*. A committee was appointed and eventually the publication has been commenced of a monthly journal entitled *Current Science*; the first issue appeared in July, 1932. You will all agree that the journal is a success, for there has been no lack of material suitable for publication and the journal is pleasantly printed on good paper. On one point, however, the Board of Editors have cause for anxiety. The University of Madras and the Indian Institute of Science have made grants towards the maintenance of this journal, and, in addition, there are receipts from the sale of the journal and from advertisements. The total receipts from these sources is not, however, sufficient to meet the total expenditure, and for its continuance the journal will require either additional grants from other bodies, or an increased number of subscribers. These are hard times and it is going to be difficult to secure donations from University bodies. But when I mention that the present year's budget of the journal has been framed on the basis of only 300 subscribers, which is less than one per million inhabitants of the country, and that 200 additional subscribers would square the budget, it will be seen that if Indian Science deserves the dignity of supporting an All-India journal in science, it can easily secure this dignity by what is really a trivial increase in the number of subscribers; for what are 500 subscribers amongst over 300 million people? No doubt, many of you have been waiting to see what the journal was like before subscribing. Now that you see the result, I hope that as many as possible will send in their subscriptions.

It has been suggested that as the Indian Science Congress may be regarded as the parent of this journal, the Congress should make a substantial annual grant to *Current Science*. This suggestion will no doubt be considered fully by the Council of the Congress; but we must remember that our Congress is not financially a profitable organization, and is itself dependent at each session upon generous donations from universities and other bodies and from the Local Government concerned, in augmentation of the subscriptions of the members of the Congress.

As this is the 20th Session of our Congress, introducing the 20th year of our existence, a few remarks on our progress may be appropriate. The history of the foundation and growth of the Indian Science Congress was given by Dr. J. L. Simonsen in his Presidential Address to the 15th Congress. This history can be accepted as authoritative, as Dr. Simonsen was, as you know, one of the Joint Founders of the Congress. From his address you will discover that the initial meeting that led to our formation was held in 1912 in the rooms of the Asiatic Society of Bengal, and that it was resolved that the Asiatic Society of Bengal be asked to undertake the management of a Science Congress to be held annually. The First Congress was held in Calcutta in 1914 under the ægis of the Asiatic Society of Bengal, and we have since been indebted annually to this Society for our resuscitation at each meeting. We have our own two General Secretaries upon whom much work falls, but two of the officials of the Asiatic Society of Bengal, namely, the General Secretary and the Treasurer, have all the time done very heavy work for the Congress, particularly in the publication of reports of our meetings and in keeping our accounts.

I use the word "resuscitation" because until 1931 our Congress had no permanent organization. In 1931, however, a constitution was adopted whereby we became a continuous organization under the title of the "Indian Science Congress Association" with a roll of permanent members, of whom at present we have about 225. In addition we recruit annually Sessional Members, Associate Members and Student Members. The administrative work of the Indian Science Congress Association is conducted by an Executive Committee of 11 Members, including the President, the retiring President, and two General Secretaries, the Treasurer (who is the Treasurer of the Asiatic Society of Bengal for the time being), and the General Secretary of the Asiatic Society of Bengal, who is really the Manager of the Congress and Editor of our *Proceedings*. In this way the historical connection between the Indian Science Congress and the Asiatic Society of Bengal has been put upon a permanent footing. This means also that the office of the Congress is in the rooms of the Asiatic Society of Bengal and that we receive the services of the General Secretary and Treasurer of that body free of charge. I have mentioned all this to indicate the extent to which the Indian Science Congress is a dependent body financially, and not yet in a position to provide donations towards laudable scientific enterprises such as *Current Science*, or

towards endowing particular researches in the manner undertaken by the British Association for the Advancement of Science in England. *Current Science* will no doubt eventually pay its way; but we could well do with funds for financing special items of research by private workers. We may hope perhaps that eventually donations for this purpose will be forthcoming from generous donors, who may perhaps remember the Indian Science Congress in their wills.

I have referred above to our *Proceedings*. As you know, the Proceedings of each meeting are now published annually by the Asiatic Society of Bengal as a special volume. This special publication dates, however, only from the 9th Meeting. The reports of the first 8 meetings were published as special parts in the *Proceedings of the Asiatic Society of Bengal*. This Society has now very generously undertaken to reprint, at its own expense, the Proceedings of the first eight meetings in a form homogeneous with the later reports. The Proceedings of the 1st, 2nd, 4th and 5th meetings have been issued and those of the 3rd are in the press. For financial reasons, the Society has found it necessary for the present to postpone the reprinting of the Proceedings of the 6th, 7th and 8th Congresses, but we may expect these eventually. In view of what I have said above it is evident that we have been very much beholden for a long period of years to the generosity and assistance of the Asiatic Society of Bengal, and I wish at this place to mention specially the name of Mr. Johan van Manen, the General Secretary of the Asiatic Society of Bengal, who has, for many years, acted as Editor of our *Proceedings* as well as helping in many other ways. It is also suitable that I should mention specially Prof. S. P. Agharkar, who has been one of our two General Secretaries since 1924, carrying on his duties in turn with Dr. Simonsen, Dr. Norris, and Dr. Dunnicliffe, and now with Mr. West, whom we welcome on the Executive Council of the Congress.

I have mentioned that this is our 20th year of existence. What is the object of our existence? According to our rules, the object of the Indian Science Congress is the "advancement of Science in India by the annual holding of a Congress". The advancement of Science may be effected in two ways. That which occurs first to our minds is undoubtedly the prosecution of research for the purpose of discovering new facts of Nature and, if possible, of explaining the meaning of these facts. But the advance of Science can also be helped by arousing the interest therein of the general public; for not only does our work conduce in many cases to the welfare of mankind, but it also requires the support of mankind in the provision of facilities and specially in the provision of finance. For both reasons, therefore, our Congress is in its annual activities a peripatetic body, meeting in turn in the principal cities of India so that each may become aware of our activities and our needs. This aspect of the scope of our activities may be summarised by the statement that in the first 20 years of our existence, we have met three times each in Calcutta, Madras and Bangalore, twice each in Lucknow, Lahore, Bombay and Nagpur, and once each in Benares and Allahabad, whilst we are now meeting for the first time in Patna. It is desirable also that we should cater for as many branches of Science as possible, not only by the creation of separate sections, of which we now have nine, which collect each the devotees of their own Science, but also in the Congress as a whole as represented by the President and his Presidential Address. It may interest you, therefore, to know that the first 20 Presidents have been distributed as follows: Medicine, Geology and Chemistry, three each; Botany and Zoology, two each; and Geography, Meteorology, Agriculture, Physics, Mathematics, Business and Engineering, one each. For the next—the 21st Congress—a Physicist has been selected.

The catholicity of our activities, both in place of meeting and choice of President, is illustrated by the foregoing figures. The extent to which this catholic behaviour and outlook has been successful is perhaps well illustrated by the astounding growth in the activities of our Congress. At the first meeting the number of members was 79, one Presidential Address was given, 35 papers were read, and the published *Proceedings* occupied 8 pages of print. Ten years later, at the 11th meeting, the number of Full and Associate Members was 403, with 290 Student Members. One general Presidential Address and 8 Sectional Presidential Addresses were given, 264 papers were presented, and the published *Proceedings* occupied 264 pages of print. At the 19th meeting, the number of Full and Associate Members was 690 and of Student Members 183. There were 10 Presidential Addresses, general and sectional,

and 693 papers occupying 467 pages of *Proceedings*. This growth in the attendance at our meetings shows increasing interest; but it is a question whether this vast increase in the number of papers presented can be desirable, for in the time available it is impossible to read more than a fraction of the papers offered. Thus at the 19th Congress 221 papers were presented to the Chemical Section; it seems unlikely that even a quarter of these can have been profitably read and discussed. Of course, this flood of papers reflects to some extent the activity of research in India in the branches of Science concerned, but one wonders if there is not some room for selection by the Sectional Committees of those papers that are most suitable for presentation at the Sectional meetings, taking into account the general interest and importance of each paper.

This growth in the activities of our Congress has been accompanied not only by a growth in volume but also in the number of recognized sections. The original 6 sections were Chemistry, Physics, Geology, Zoology, Botany and Ethnography. Agriculture was added at the 2nd Congress. The Physics section became the section of Physics and Mathematics at the 4th Congress, when Ethnography was also amalgamated with Zoology. At the 6th Congress the sections were increased to 7 by the addition of a section of Medical Research. At the 8th Congress, Ethnography was separated from Zoology again and made into a separate 8th section of Anthropology and Ethnography to become a section of Anthropology at the 9th Congress. At the 12th Congress a 9th section of Psychology was added, and these are our 9 sections now.

During the vast growth in the number of papers read at several of the sections, Geology has remained a small section, and the largest number of papers that has been presented at one meeting is 36 The relatively small number of papers offered in this Science is partly due no doubt to the fact that the meetings are held at a time when the officers of the Geological Survey of India are absent on field duties, and to geologists as a whole not caring to offer papers if they cannot be present to read them. Some other sections, *e.g.*, Anthropology and Psychology, also are happy in that a manageable number of papers is presented, and I commend the example of these smaller sections to the notice of some of their bigger brethren.

II.—THE PLACE OF GEOLOGY IN THE LIFE OF A NATION.

This brings us to the end of my remarks upon matters connected with the progress and welfare of our Congress. I now propose to discuss in as general a manner as possible, a subject of more specialized interest, namely, the Place of Geology in the Life of a Nation.

Those of you who have pondered upon the relationship between cause and effect must realize that anything that happens now to any person or thing may be regarded as the latest unit in a continuous chain of cause and effect. And you will probably permit me to summarise epigrammatically the results of your thoughts by likening life to an algebraical equation.

As you know, an important feature of such an equation is that the sum of the items on the right side must equal the sum of the items on the left side. Life is rather like this. A present happening may be regarded as the right side of an algebraical equation, and all the events that have led up to this happening may be regarded as constituting the left side of the equation.

To take an example, the fact that I am addressing you this evening here depends upon the facts, among many others, that I was born on a certain date, that I took up the study of science, that I was diverted to geology from metallurgy, the profession I originally selected, that I secured an appointment in India, that I have remained in service until this date, that your council chose this place and date for our meeting and selected me to preside, and that I have succeeded in reaching this room without being involved in any accident. If any one of the facts mentioned had been different, I should probably not be here this evening.

An equation of this type, that is to say, one involving cause and effect, differs in one essential particular from the algebraical equations of our class rooms. The equations of our school algebra are static equations, whereas those of the type we are now discussing are kinetic ones. For on each side of the equations of life there is an energy factor implying movement in the past and the possibility of movement in the future.

It is this energy factor that conditions Evolution, which, using our simile, may be described as the grand and impressive kinetic algebraical equation of the universe, on the left side of which is included not only the magnificent succession of events constituting

the evolution of the stellar universe, but also the section of these events that has led to the evolution of the solar system and the birth of our planet; in addition it includes the much smaller, though to us vitally important, series of events that has led to the evolution of life upon our planet including the evolution of Man, followed by the still smaller series of events that constitutes the progress of human history down to its present point. The major portion of this grand series of events is the field of study of the Astronomer. With the formation of the earth, the field of study of the Geologist was provided. The evolution of life falls also within the realm of the geologist; but the latest section of this series of events, affecting human beings, falls within the sphere of studies of the Historian. The study of the present results of this evolutionary series of changes falls within the realms of Geography, Meteorology, Botany, Zoology and Anthropology, to mention sciences that in their historical or fossil aspect are comprised under geology.

You will now ask "Then what is geology and the true field of study of the geologist?" I cannot do better than quote the two opening paragraphs of Sir Archibald Geikie's 'Text-book of Geology':—

'Geology is the science which investigates the history of the Earth. Its object is to trace the progress of our planet from the earliest beginnings of its separate existence, through its various stages of growth, down to the present condition of things. Unravelling the complicated processes by which each continent and country has been built up, it traces out the origin of their materials and the successive stages by which these materials have been brought into their present form and position. It thus unfolds a vast series of geographical revolutions that have affected both land and sea all over the face of the globe.

Nor does this science confine itself merely to changes in the inorganic world. Geology shows that the present races of plants and animals are the descendants of other and very different races that once peopled the earth. It teaches that there has been a progress of the inhabitants, as well as one of the globe on which they have dwelt that each successive period in the earth's history, since the introduction of living things, has been marked by characteristic types of the animal and vegetable kingdoms; and that, how imperfectly soever they may have been preserved or may be deciphered, materials exist for a history of life upon the planet. The geographical distribution of existing faunas and floras is often made clear and intelligible by geological evidence; and in a similar way, light is thrown upon some of the remoter phases in the history of man himself.'

From this you will gather that geography is the branch of geology that describes the particular shape and form of the earth's surface at the moment. With the continuance of the operation of geological processes geography changes slowly through the ages, and looking backwards and making use of geological observations, we find that at previous periods in the earth's history the distribution of land and water, of mountain and valley, has often been vastly different from the present.

The geography of the earth at any moment including its climate, flora and fauna, and the inherent possibilities of further change, is, in fact, the right side of that kinetic algebraical equation, of which the left side is the geological history of the earth down to that moment. In fact, in mathematical parlance, the geography of the earth is a function of its geological history.

Those of you who have studied history, by which I now refer to human history, must have noticed the extent to which this history is related to geography: how coasts, seas rivers, mountains and climates have exercised an important influence over the migration of races, and their struggles, one race with another, and upon the distribution of tribal and national boundaries. It is probable, nevertheless, that the majority of you have not realized that the guiding factors underlying geography were geological ones, and that, in fact, the events that constitute geological history have exerted a profound and far-reaching influence upon the history of mankind, both in general and in detail.

On the wall here is a geological map of the world.[1] The colours indicate the distribution of geological formations of different ages and origin. As you know, the land of the world occupies about a quarter of the surface, the oceans occupying the remaining three-quarters. According to some geolo

[1] F. Beyschlag, 'Geologische Karte der Erde, 1929–1932.

gists, the land area was once vastly greater, and according to most, the proportion of land and sea has varied greatly throughout the ages. One major deduction based on widespread geological evidence is that South America, South Africa, Australia, India and Antarctica were once all part of a continuous continent known as Gondwanaland. Views differ as to the method by which this continent was dismembered. According to one hypothesis, known as the hypothesis of continental drift,[1] the existing continents were grouped in Carboniferous times as one continuous land-mass, with all the existing parts of Gondwanaland in apposition to Southern Africa. Subsequently, on this view, the continuous land-mass was fractured, with drifting apart of the fragments to form the present continents. On this view, India was once attached to Africa near Madagascar, and gradually floated or drifted north-eastwards.

The second and older hypothesis, whilst accepting the fact of Gondwanaland, supposes that it was formerly a much larger continent than can be deduced by simply fitting the existing fragments together, that Africa and India were then at approximately their present distance apart, and that the separation of these two countries was effected by the foundering or sinking of the intervening portions of the continent. Some geologists find it difficult to visualise the machinery of foundering, and consequently support *in toto* the hypothesis of continental drift. Foundering can be explained, however, either by the compression of rocks underlying the sunken parts of the continent into a denser phase, *e.g.*, gabbro into eclogite,[2] or by the lateral underground squeezing of magma from below the foundering portions. Whichever of these hypotheses relating to the break up of Gondwanaland be true, the cause has to be found. I do not propose to discuss this here, but only to point to the fact that the existing fragments of Gondwanaland are now separate, and that India has sea-coasts that she would not have had but for this disruption. Mr. West proposes to discuss the hypothesis of continental drift in one of our evening lectures, so that I need not refer further to this question. As a side-issue I may mention, however, that the expedition that Col. Sewell is to lead to the Arabian Sea may obtain, if rock specimens in any quantity can be secured from the bottom of the ocean, evidence helpful to the determination of whether India has been separated from Africa by the foundering of the intervening land, or by drifting apart.

I will now invite your attention to these two maps of India, one geological and the other orographical. India is a large country, whilst the number of geologists who have been at work therein is small; in consequence, there are still great gaps in our knowledge, and our geological map is a very imperfect production. Sufficient, however, has been ascertained to reveal the general outline of the geology of India and to render possible a comparison between the geology and the orographical features as represented in these two maps. From this comparison you see at once that there must be some close relationship between the geology of India, that is to say its geological history and the present topographical features. From these maps you will see also that the Indian Empire, as at present constituted, is one of the most natural geological and physical units on the surface of the earth.

Geologically speaking, the Indian Empire may be regarded as consisting of three parts. There is first the Peninsula stretching southwards to Cape Comorin from its apex at Delhi; it is a remnant of the old Gondwana continent. To the north of this is the second unit, the Indo-Gangetic alluvium, composed of sands and clays, laid down, in geologically recent times, upon what is really a bent-down portion of Gondwanaland. To the north of this alluvium is the third unit composed of three mountain festoons with their convexities directed towards the peninsula. On the north-west is the first festoon composed of the arcs of Baluchistan and the North-West Frontier Province; on the north is the second festoon, the magnificent arc of the Himalayas; and on the north-east, is the third festoon, composed of the mountain ranges of Assam and Arakan and the Andaman and Nicobar Islands.

[1] Osmond Fisher, 'Physics of the Earth's Crust,' pp. 339, 380 (1889).
W. H. Pickering, *Journ. Geol.*, XV, pp. 23–38 (1907).
F. B. Taylor, *Bull. Geol. Soc. Amer.*, Vol. 21, pp. 179–226 (1910).
A. Wegener, 'Die Entstehung der Kontinente und Ozeane' (1922): English translation (1924).

[2] L. L. Fermor, 'Preliminary Note on Garnet as a Geological Barometer and on an Infra-Plutonic Zone in the Earth's Crust,' *Rec. Geol. Surv. Ind.*, XLIII, pp. 41–47 (1913).

The northern edge of Gondwanaland is actually on the north side of the Indo-Gangetic alluvium, and lies in the outer ranges of the Himalayas; the Assam plateau may also be regarded as a fragment of this old continent; and as the Indo-Gangetic alluvium rests upon what must be regarded as a downwarped portion of Gondwanaland we can in fact reduce our elements to two, of which one is a fragment of Gondwanaland represented by the Peninsula of India, the Indo-Gangetic alluvium, the outer ranges of the Himalayas, and the Assam plateau. The other element is represented by the three mountain festoons of the north-west, the north and the east, which appear to result from the overthrusting of Asia on to this fragment of Gondwanaland.

There is a difference of opinion whether this relationship has been produced by the underthrusting of the Peninsula of India against the mountain lands of Asia, or by the overthrusting of the high lands of Asia on to Gondwanaland. The resulting Indian Empire, however, is an approximate geological whole with a crude bilateral symmetry about a N.N.E.-S.S.W. line that is reflected in the geography and orography of the Indian Empire. The exact outer limits of this Empire are, nevertheless, difficult to select on geological and, therefore, geographical grounds, and are dependent upon the details of history; but there can be no doubt that, looked at from a broad point of view, Burma, or at least the western portion thereof, must be regarded as an integral portion of the Indian geological and geographical unit.

General geological factors have thus given rise to a natural unit comprised of a hilly and wooded peninsula bounded on the west, south and east by seas and on the north by fertile plains, which are themselves limited by bordering mountain ranges to the north-west, north and east. The protective action of these bordering ranges would have been complete were it not for the operation of more local causes, such as faulting and river erosion in producing the gaps known as passes. The existence of these passes has had a profoundly important influence upon the human history of India.

Students of this history are aware that throughout the ages there has been a succession of waves of invading races that have taken advantage of the passes in the high mountain walls, specially on the north-west but to a small extent on the north-east; and they are aware how each successive wave of human invasion has pushed the remnants of the previous invasions further south into the Peninsula.

The fact that the Peninsula of India is bounded to the southward by seas was until a relatively late date in the history of India a limiting factor to changes in that history by providing a boundary beyond which the inhabitants could not be driven by further invasions from the north, and also by acting as an obstacle to the arrival of any disturbing invasions from the south. Later, however, this very factor of the existence of sea-coasts, once the Cape of Good Hope had been rounded by the Portuguese investigator Vasco da Gama, provided a means by which invaders from a far-distant part of the world, Europe, were able to reach India. Had, however, the disruption of Gondwanaland never occurred, the Peninsula of India would have remained embedded in a continent and would, consequently, have had no coasts; there would have been no European invasions by sea and the whole history of the country for the last few centuries would have been profoundly different.

As another instance of the manner in which the existence of the sea has reacted upon the history of India, attention may be drawn to the eastern festoon constituted by the Tertiary mountain ranges of Assam and Arakan. Had their continuation through the Andaman and Nicobar Islands to Sumatra and Java not been breached, these ranges would have acted as a barrier between India and Burma almost as effective as that between Tibet and India provided by the Himalayan ranges. The mere fact that the events of geological history have caused this range to be discontinuous with the isolation of the Andaman and Nicobar Islands and the provision of the sea passage from India to what is now Rangoon, led in an inevitable manner to the addition of Burma to the Indian Empire.

To illustrate still further the effect that geology may have upon the distribution of national boundaries, I invite your attention now to the geological map of Europe, though I regret that I have not been able to provide one on a larger scale. A comparison of this map, or of the corresponding orographical map dependent upon it, with the political map of Europe will reveal the extent to which national boundaries in Europe are based upon natural factors.

You will observe, for example, how the approximate position of the frontier between Spain and France is determined by the existence of the Pyrenees, which with the seas isolate Spain and Portugal as one natural unit. You will see how Italy may be regarded as another natural unit bounded by the Alps on the north and otherwise by the sea. Similarly, the Scandinavian Peninsula, composed of Norway and Sweden, is a natural unit: you will notice also that Finland is geologically allied to Sweden and not to Russia, so that it is not strange that Finland has succeeded in eventually obtaining her independence from Russia, although the national boundary between Finland and Russia is not in agreement with the geological boundary.

It will be noticed on the other hand that it is difficult to select on natural grounds a precise position for a frontier between France and Germany, as also for the frontiers of many of the countries of Central Europe. This lack of correlation between natural and national boundaries in Central Europe may, in fact, be regarded as the ultimate cause of the Great War, a more proximate cause being the ownership of the coal-fields and iron-ores of the Franco-German frontier lands. The broad truth is that in many parts of Europe nationality is on a smaller scale than geology and is consequently upon a precarious basis: from which it appears, if we may rely upon geology, that national stability will not be attained in Europe until the countries have in many cases been grouped into much larger units. The results of the partition of the Austro-Hungarian Empire as a result of the Great War provide an example of a particularly flagrant violation of nature; and economic grounds alone, it may be predicted, will eventually cause racial considerations to be subordinated to common economic interests resulting from physical factors.

Directing our attention once again to India we find we have here a country of the size of Europe without Russia, containing at least as many different races with at least as great a diversity as in Europe. India is fortunate, however, in that the general geological conditions have caused the inhabitants, in spite of their diversity of race, religion and language, to be welded, after struggles through the ages, into one political unit. As with national boundaries in Central Europe the boundaries between the provinces in India pay little attention in many cases to geological considerations. The province of Bihar and Orissa for instance, in which we are now meeting, is an excellent example of the violation of natural principles by provincial boundaries. But as long as a central political control remains, it does not matter seriously that the boundaries between our provinces take such little account of natural factors. Were the central control, however, removed and all political relationship to one general suzerain power severed, then the future history of India would again become as confused as it was in the past and as confused as that of Central Europe has been throughout the ages and promises to become again in the future.

I have suggested in the short time at my disposal the profound influence upon the history of a nation and upon the determination of its boundaries that may be exerted by geological factors, how relative national stability appears to be attained in cases where natural boundaries are based on physical features, and how the history of a country in respect of its extent and government appears to become confused and doubtful in cases where national boundaries have been laid down in defiance of physical considerations.

Leaving the general for the particular, I propose now to point to a few precise events and sets of conditions in India that can be ascribed to particular events in the geological history of the country.

In the first place we may refer to the position of the capital. There is no doubt that the defence of any country is one of prime importance, and that, therefore, the position of greatest internal strategic importance may have claims for selection as the capital of the country. A glance at this map will show you that Delhi, by virtue of its position at the apex of the Peninsula, occupies the most strategic point in India with reference to the internal peace of the country. For Delhi is at the point where the plains of the Indo-Gangetic alluvium that separate the Peninsula from the Himalayas become most constricted, the point consequently at which it is easiest to defend the fertile plains of the Jumna and the Ganges to the east against invasion from the west, the direction from which most of the major external invasions of the past have come. It is not surprising, therefore, that in the past history of India there have been three decisive battles at

Panipat[1] in the plains north of Delhi. It is this position at the apex of the Peninsula that caused Delhi to be the capital home of the Moghal Emperors and their predecessors, and which really caused the removal of the capital of India in recent times from Calcutta to Delhi.

But the welfare of a country does not depend only upon defence and politics. Commerce and industry are also of vital importance and, in so far as they are the true sources of wealth to a country, their importance may transcend military and political factors. It will be seen that a point somewhere in the delta of Bengal, by its connection with the Hinterland of the Gangetic valley and the highlands of Assam, its sea connection to Burma and Southern India, and its proximity to the coal-fields of Bengal, Bihar and Orissa, seems to be a natural site for a commercial and industrial capital; it is because of the existence of these underlying natural factors that Calcutta continues to be the commercial capital of India, in spite of the removal of the political capital to Delhi.

The ultimate factors that have caused upon the selection of Delhi as the political capital of the Indian Empire with the *de facto* retention of Calcutta as the commercial capital date back to the series of events that caused the break-up of Gondwanaland, followed by the elevation of the Himalayas and the deposition of the alluvium of the Indus, the Ganges and the Brahmaputra.

Another important item in the sequence of events following the break-up of Gondwanaland was the eruption of the Deccan Traps that cover some 200,000 sq. miles of Western India. For it is the eruption of these lava flows that is the real cause of the greatness of Bombay. Bombay depends mainly upon the cotton industry, and the latter is dependent upon the fertility of the black cotton soil derived mainly from these lavas. The foundations of Bombay were, in fact, laid, when the Deccan Traps were poured forth, let us say 75 million years ago.

Other events in the modern history of India can, however, be attributed to dates much more ancient than this; for example, the institution of the iron and steel industry at Jamshedpur in this province. This industry is dependent for its supplies of iron-ore and limestone upon deposits that were laid down in Archæan times, and upon deposits of coal laid down in early Gondwana times. We may ascribe an antiquity to these deposits of iron-ore and limestone of something between 600 million and a thousand million years, and to the coal an antiquity of some 200 million years. The foundations of the iron and steel industry at Jamshedpur were thus laid down at periods ranging from, say, 750 to 200 million years ago.

Numerous other examples could be cited of the dependence of particular events or industries upon past events in the geological history of India: but time does not permit.

The examples given all illustrate the manner in which geology has affected man, without his being conscious thereof: they illustrate the action of cause and effect in which mankind appears as the helpless child of geology.

There is, however, another aspect of our subject in which man derives conscious benefit from his geological heritage by utilizing the rocks, minerals and structures now lying at or near the surface of the globe. This may be described as the utilitarian side of geology, and this I have already discussed at some length in my Presidential Address to the Mining and Geological Institute of India in 1922 under the title of the "Utility of Geology to Man".[2]

It is unnecessary to enlarge upon this branch of our subject here, except, for the sake of completeness, to mention that on the utilitarian side geology helps not only in the development of mining and metallurgical industries, but also in many branches of engineering, both in the provision of materials and in structural problems dependent upon the strength and disposition of rocks such as those connected with foundations, with the study of landslips and earthquakes and with the alignment of railways. Further, as a result of the development of mineral and metallurgical industries, geology becomes the cause not only of revenue to Government in the shape of income-tax and royalties, but also of the creation of a widening circle of employment, starting from employment to miners and smelters and spreading out to employment for the great transporting agencies, the railways and shipping companies, to mention only a few of the interests that benefit.

[1] Babar defeats Ibrahim Lodi (1526); Akbar defeats the Afghans (1556); Ahmad Shah Durani defeats the Marathas (1761).

[2] *Trans. Min. Geol. Inst. Ind.*, XVII, pp. 16-40 (1922).

But should the conscious use of geology by man be confined to these directly utilitarian but relatively minor purposes? Should man not, as a result of his studies of the trend and influence of geological factors on a large scale, attempt so to adjust national and international life to these factors as to help the growth of national welfare and international peace; instead of, as so often happens, pursuing, in indifference to these natural factors, courses of action that tend to increase national or international disequilibrium?

It is mainly for utilitarian reasons, however, and partly, perhaps, because in addition it is realized that a country should know herself, that every civilized country maintains a Geological Survey Department for the purpose of ascertaining the factors upon which so much appears to depend.

I have already mentioned the approximation between the size of India and the continent of Europe without Russia. This was brought out forcibly in a map published recently by the *Statesman* in which Europe was treated as a jig-saw puzzle, and the countries of Europe excluding Russia were fitted into India excluding Burma. I show this map now upon the screen. It is difficult to secure exact figures of the strengths of the geological surveys of the various countries. But they amount to over 300, of which 78 are employed in Germany and 52 in Great Britain, whilst several of the less advanced countries, namely, Albania, Bulgaria, Esthonia, Latvia, Lithuania, and Turkey, appear to have no geological survey department. In India we have a staff of 24 for the study of the geology of the whole Indian Empire including Burma. Of these about 6 are employed in Burma, leaving 18 for the study of an area equal to that for which Europe provides over 300 geologists. Square mile for square mile, India is, of course, much less wealthy than Europe, but from the figures given above it is seen that if India is properly to know herself, she must contemplate in the future—it may be near or it may be distant—the employment of a much larger number of geologists than at present or than were employed before the recent drastic reduction in the strength of the Geological Survey of India effected as a measure of retrenchment. My faith in the value to a country of the work of geologists, coupled with the fact that in India in particular the accrued yearly direct and indirect financial benefits to Governments—Central and Provincial—is several times the annual cost of the Geological Survey Department, leads me to believe that re-expansion, followed by further growth, will eventually and inevitably be regarded as a vital financial necessity apart even from the influence of general and cultural reasons the importance of which will be increasingly realized.

I have alluded just now to the cultural aspects of geology. It will be readily apprehended that the study of a subject related so fundamentally to life is admirably suited for inclusion in university curricula. At present the scope for new employment for geologists in India has fallen almost to zero: but this does not mean that geological classes in University institutions should be closed. For young men should be encouraged to study geology not for the purpose necessarily of earning their living thereby, but as a branch of general culture, some knowledge of which is desirable to a man in whatever profession or walk of life he elects to earn his living. It is, in fact, not an exaggeration to say that no university that does not provide instruction in geology can truly and strictly be regarded as a university in the true sense of the word.

I have now reached the end of my address. In attempting to show the importance of geology in the life of a nation, it has not been my intention to magnify this science at the expense of others. All the sciences are inter-related, and geology in particular makes contact with many others, but specially with astronomy, meteorology, botany, zoology and anthropology, and also with the two sciences that deal with matter in its atomic and molecular aspects, namely, physics and chemistry. Moreover, we live in the present: the study of the present aspects of nature is, therefore, of as great importance to us as the study of nature in her historical aspects, with which geology is so greatly concerned. The importance of the study of the historical side of nature lies in the fact that such study helps us to understand how the facts of the present have arisen; and, because life is a kinetic affair, this historical study helps us to obtain sometimes a glimmering of the future, and even to suggest, however diffidently, the extent to which a measure of control of the future may lie within the grasp of mankind if we will but have the foresight and the courage.

Sectional Addresses.

AGRICULTURE:

THE acuteness of the present agricultural depression has been aggravated by organized, heavy crop-production in some parts of the World and introduction of synthetic substitutes for natural products in others. The pursuit of agriculture has, more or less, ceased to be remunerative and, considering the present conditions in the country, the future appears to be all but bright!

During the past thirty years, the agricultural departments of India have striven hard to effect various improvements; but in spite of the introduction of better implements and high yielding varieties, growing knowledge of suitable rotations and better facilities for irrigation and marketing, the situation has not appreciably improved—in fact, it has become worse as indicated by the increased suffering and greater indebtedness of the peasantry.

An analysis of the position shows that a large part of the trouble is due to our ignorance of the influence of environment on crop-yield. Successful crop-production is essentially the result of reciprocal reaction between the plant and its surroundings, but in our enthusiasm for the former we have overlooked the importance of the latter.

As an instance of the importance of environment may be mentioned the influence of season which (*a*) introduces greater differences in crop-yield than all the varieties introduced by man, and (*b*) so obscures the effects of manurial treatments that, in spite of three decades of experience, agricultural experts are still unable to give satisfactory advice to cultivators! Crops are often sought to be raised under soil and climatic conditions which are not generally favourable to them. Thus although the Punjab American cottons are superior to the indigenous *Desi* in length of lint, their ecological amplitude is narrower and hence their failure more frequent than that of the latter. Soil conditions, chemical as well as biological, also determine the success or failure of crops. It is a notorious fact that most Indian soils have reached the limit of maximum impoverishment but still high yields are expected to be obtained by the introduction of new varieties! Moreover, our knowledge of the reciprocal reactions of the soil, the crop and the micro-organisms is so limited that we rarely ever strike a favourable balance: thus, when off-season cultivation was attempted in the Punjab to eradicate the moth borers of rice, the yields went down by as much as 42 per cent! The concentration of carbon-dioxide in the atmosphere is also a factor determining the efficiency of plant growth but so far very little use has been made of this knowledge.

Every country—nay every tract—has to solve its own ecological problems. The problems of the Punjab are different from those of Bihar or South India and must be studied in full cognisance of the local conditions. This would apply particularly to the depredations of pathogenic organisms and insect pests which should be tackled in the same way as medical men forestall possible outbreaks of epidemics. The literature on plant pathology abounds with instances of allied phenomena showing the importance of environment in determining the abundance and distribution of various pests.

A striking example of the above is the Desert Locust which appears, in swarms, at intervals, spreading over Baluchistan, the Indo-Gangetic plain, Rajputana and West Central India, breeds for a few generations and then disappears. One naturally likes to know where the locusts come from, what they do during non-swarming seasons, why they migrate from their homes and in such large numbers and finally how to prevent the recurrence of their invasions in the future. The researches conducted by the author and his co-workers under the auspices of the Imperial Council of Agricultural Research show that: (*a*) the permanent breeding ground of the Desert Locust lies in parts of Baluchistan and the Indus valley; (*b*) that it thrives best in dry weather but perishes readily in a humid atmosphere, thus accounting for the rapid disappearance of the locust from the Gangetic plain shortly after every invasion; (*c*) that the rapid multiplication preceding their big flights is facilitated by a succession of seasons with good rainfall; (*d*) although when occurring in small numbers they are quite harmless, they turn out bold and highly aggressive during their flights; and (*e*) prior to their migrations the locusts multiply rapidly in their desert homes, shed their protective colouration and turn into dark hoppers. The above information, though not sufficient to eradicate the pest altogether, should still be helpful in warning the cultivators or otherwise minimising their depredations.

V. S.

ANTHROPOLOGY:

IN his Presidential Address at the Anthropological Section of the Indian Science Congress, Dr. P. Mitra refers in his introduction to the research thesis of a few of the Post-graduate Students as part of work for their M.A. and M.Sc. degree examinations, as also to the research work of the members of the Anthropological Department of the Calcutta University since its organization in 1921.

Research leads in India, says the President, saw the starting of linguistic classification of mankind with the Asiatic Society of Bengal. Pater Schmidt, Sten Konow and Grierson have after their laborious researches, shown fresh fields for further investigations. The Austro Asiatic or Pre-Dravidian problem is engaging the attention of scientists. The Dravidian linguistic problem is still unsolved, and the comparative study of Milanesian languages by Dravidian scholars may promise to open up fresh fields. The President then refers to the patriarchal theory of Sir Henry Main, Morgan's wonderful discovery of the relationship terms and its correlation to the Dravidian and Senecan system for the solution of some anthropological problems. In his opinion a detailed and comparative study of some of the Australian and South Indian tribes is calculated to produce promising results for the solution of the Dravidian problem. Special emphasis is laid on the marriage systems of these tribes as helpful to the discovery of cultural affinities. The origin of exogamy, in the opinion of the President, is sti

shrouded in mystery in spite of the numerous theories that have been formulated by the various anthropologists and the ancient Hindu rishies.

The President gives some parallelism between the early developed culture in Northern India and Polynesia. Further the stratic graphic study of culture in the line of the German school and mapping out of culture areas are recommended. Definite distribution of traits of a culture complex is far more yielding of results in the fields of material culture. The study of material culture traits common to India, Africa and the Pacific might lead to produce types which are likely to have originated in a central home before dispersal.

The recent studies of Dr. Broom in South Africa reveal the probable existence of a South African Australoid race who have left similar physical traits. In the opinion of the President, India can be studied in comparison with the data from Africa on the one hand and the Pacific on the other. The implements in South India and Tasmania are said to be similar. As probable survival of the early stone age culture complex, boomerang plays a prominent part. Griebner in his classic study of the Milanesian bow culture has shown five stratifications of which the old Australian culture with boomerang was the earliest, and this was followed by totemic culture, and then a matriarchal dual organization after which came the boomerang bow culture complex and still later the Polynesian culture. The boomerang, says the President, is common to Africa, India and to Australia, as may be seen from the specimens exhibited in the Pitt-Rivers Museum of Oxford. Similarly the study of the bow will also yield valuable results.

The study of the problem relating to the dispersal of taro and banana and of domesticated animals, study of culture of intercontinental regions will reveal important role of India as primary or secondary centre of diffusion of cultures in several stages of her culture complex in the march of time. The study of the origin and development of plough yields important results. Finally India has to take inspiration from her cultural patterns so as to be able to combine with the cultural traits of the West and break into new paths. Finally he concludes his address by referring to some super anthropological problems.

L. K. A.

BOTANY:

THE study of algæ did not receive for a long time the attention due to it from Indian botanists. One main reason for its neglect is the general impression that a study of this group of plants can hardly be of any economic value. So, while Mycology, Plant-Breeding and Plant-Physiology are drawing most of our men, subjects like Algæ which are supposed to be of academic interest only fail to attract any of them. It is gratifying to see, however, that of recent years more people are taking to the study of algæ. An attempt is made in this address to show among other things how a study of algæ, besides throwing valuable light on fundamental biological problems, can also be of value economically.

It is generally believed that life first originated in water and that the first living organism must have been of an algal type. And a detailed study of these plants will throw light on the problem of the origin of life, the solution of which is the ultimate goal of all biologists. Again a study of this group will enable us to understand many biological principles such as division of labour, parallelism in evolution, the phenomena of differentiation of somatic and reproductive cells, origin of sex, alternation of generations, adaptation to land life, etc. And the structure, function and origin of cellular bodies like the nucleus, plastids, pyrenoids, blepharoplasts, chondriosomes and golgi bodies are more likely to be understood by a careful study of this group of plants than of any other.

The different systems of classification of algæ are briefly dealt with, particular emphasis being laid on the flagellate origin of algæ, the main differences between the *Isokontæ* and the *Heterokontæ*, the parallel evolution seen in both these two groups and the existence of "flagellate" and "algal" forms in all the main algal groups. Reference is made to the works of several algologists on these simplest types of algæ and the desirability of work being done in India on similar lines is emphasized.

The work done on the ecology of algæ by several workers like West and Pearsall, Naumann, Fritsch, Donat and others is briefly described. Among other points, the ecology of freshwater lakes as described by these authors is explained in some detail. The classification of lakes as under Oligotrophic, Eutrophic and Dystrophic ones is explained and the effects of various factors such as the depth and form of the lake, the sediment, the hydrogen-ion concentration, the surroundings of the lake, etc., on the nature and composition of the algal population are described.

The ecology of subærial algæ is next described and an account is given of the important role these algæ play in colonising new and inhospitable strata, which are thereby rendered more habitable for higher plants. The need for research work on the ecology of algæ in India is pointed out.

The possible lines of work on the cytology of algæ in India are referred to, particular emphasis being laid on the possible presence of structures similar to Golgi bodies and mitochondria in algal cells.

Lastly, the economical aspects of the study of algæ are dealt with in some detail. The value of algæ on the growth of fishes is briefly explained. The algæ form the food of minute animals, which in their turn form the food of larger animals, which in their turn again serve as food for fishes, so that possibility of fish-life in any area is ultimately dependent on the presence of these minute lowly plant organisms. Investigations on the algal population and the various physical and chemical features which control their growth will help to control the nature and extent of the fish-population in any area.

The need for the establishment of freshwater biological stations for investigating hydrobiological problems in India as has been done in other countries is pointed out.

The study of algæ in relation to agriculture is next dealt with and the importance of determining whether the algæ growing on cultivated soils are beneficial or harmful to the crops is pointed out.

Many scientists have adduced evidence to suggest that the algæ are able to fix the free atmospheric nitrogen. If this should prove to be true, the growth of the algæ must be encouraged on the fields.

The study of algæ is necessary in connection with town water supplies. In the reservoirs there is usually a fair amount of algal growth. The physical and chemical conditions of the water in the tanks and the nature of the algal population should be studied, and, when necessary, measures should be taken to check or altogether eliminate the growth of the algæ in order to ensure a pure water supply.

Many mosquito larvæ depend on algæ for their food and hence there is a possibility of checking the growth of the larvæ by controlling the growth of the algæ. It is reported that mosquito larvæ do not flourish in waters in which *Characeæ* are growing. If this should prove to be correct, then we have another method of getting rid of the larvæ.

Algæ are used as manure in Rajaputana, as they are very rich in nitrogenous material. It is not known whether they are used for a similar purpose in other parts of India. Characeous deposits are used as manure in Switzerland. Moreover, the peculiar odour emitted by them is said to help in keeping the soil free from insects.

M. O. P.

CHEMISTRY :

IN the first part of his address Prof. Neogi draws attention to an analysis of the causes which have led to the remarkable increase in the output of original work in chemistry throughout India during the last 20 years. Sir P. C. Ray along with Sir Alexander Pedlar and Dr. Richardson shares the glory of being among the pioneers of chemical research in India. Every paper of Sir P. C. Ray was commented upon by newspapers of the country, thirty years ago, as proof of the capacity of Indians for original work in chemistry but at the present day, only the most outstanding discoveries like Raman Rays attract the attention of the Indian public. The principal causes which have contributed to this change are: (1) the establishment of post-graduate departments in most Indian Universities; (2) expansion and consolidation of purely research institutions like the Indian Institute of Science at Bangalore and technological departments in some Universities; (3) establishment of industrial and scientific departments by provinces and native states; (4) institution of the M.Sc. and D.Sc. degrees with fellowships and scholarships for research in many Indian Universities. But as important as any is the formation of the Indian Science Congress through the efforts of Professors J. L. Simonsen and P. S. MacMahon whereby different workers throughout the country were brought into touch with one another more closely and inspired the youth to emulate the work of the elders. Research has kept pace with the growth in opportunities for work, these thirty years. Dr. Neogi suggests the institution in Indian Universities of the Ph.D. degree for original work after M.Sc. stage, though still assisted by the teacher and pleads for greater help to the research student by a larger number of liberal research scholarships in Indian Universities, similar to those prevailing in the Indian Institute of Science at Bangalore.

The next portion of the address gives an account of optical isomerism as applicable to co-ordinated inorganic compounds. Optical isomerism was, as is well-known, explained by Le Bel and Van't Hoff in 1874 by the tetrahedral space arrangement of carbon linkages. In the next few decades, numerous classes of optically active compounds of elements other than carbon, such as N, S, P, As, B, Sn, Pb, Si and inorganic co-ordinated compounds of Co, Cr, Be, Pt, Ru, Rd, Ir and Pd were discovered and their isomerism explained by the newer conception of the arrangement of atoms in space. Werner was the pioneer in extending the conception of space representation to co-ordinated inorganic compounds. He and his co-workers soon discovered that (1) a co-ordination complex usually contains six monovalent groups round the central metal atom; (2) compounds containing complex of the type $[MA_6]$ or $[MA_5B]$ do not exist as isomers; (3) cis- and trans-isomerism exists in compounds containing complex of the type $[MA_4B_2]$ or $[MA_4BC]$; (4) In such cis-compounds if A_4 be substituted by two radicals, like oxalato or ethylenediamine, each occupying two co-ordinate positions in the complex, the compound will exhibit optical isomerism. In a complex of the type $[MA_6]$, A_6 be substituted by three radicals like oxalato or ethylenediamine, each occupying a double co-ordinate position, such complex will also exhibit optical isomerism.

The repeated occurrence of co-ordination number six among the complex salts led Werner to suppose that the substituents were placed at the corners of a regular octahedron having the central metal atom at the centre. He was able to prepare all the ten theoretically possible cobaltic-dinitro-ethylenediamine-propylenediamine compounds and all the twelve trispropylenediamine compounds in agreement with the octahedral structure. Varied and extensive experience and X-ray examination has overwhelmingly confirmed this view. The first optical isomers were isolated by Werner and Kling in 1911 and thus this branch of chemistry is only of 20 years' growth.

The first active co-ordinated inorganic compound contained cobalt as the central element. Soon Werner was able to isolate active complex compounds containing other elements of groups VI and VIII Cr, Fe, Ni, Ru, Rd, Pd, Ir and Pt. Recent work of Mills, Lowry, Wohl and others proves that elements of other groups, Cu, Be, Zn, B, Al and As also yield co-ordinated compounds. The resolution of hexol-dodecammine-tetracobaltic bromide $\{CO[CO(NH_3)_4(OH)_2]_3\}Br_6$ by Werner (1914) into *d* and *l* forms gave a blow to the belief that organic radicals are essential for optical activity in co-ordination compounds.

Both Le Bel and Van't Hoff postulated in the case of carbon compounds that, for optical activity to occur in a molecule, it must have at least one carbon atom attached to four different radicals. Later work as that of Pope, Perkin and Wallach (1909) on 1-methyl cyclohexylidene-4 acetic acid showed that the doctrine of the asymmetric atom is no longer a fundamental concept but is only a part of a wider truth. The successful resolution of cis- or tris-ethylenediamine or similar compounds which do not have any asymmetric atom, brought out

the fact that the indispensable condition for optical isomerism is that the molecule of the compound should be asymmetric and non-superposable with its mirror image. Thus Werner's work confirmed the inadequacy of the Le Bel and Van't Hoff's theory of the asymmetric atom.

In the resolution of racemic co-ordinate inorganic compounds all the three methods discovered by Pasteur have been tried. There is no record of any successful resolution by living organisms, bacteria or moulds. Only one instance of self-resolution by spontaneous crystallization is on record, *viz.*, that of Potassium Cobalti-oxalate by Jaeger and Thomas (1918). The remaining method, resolution by combination with active compounds, has been exclusively employed with inorganic compounds.

Search for an analogous compound of the tartaric acid type resulted in the discovery in 1913 by Werner of tetraethylenediamine-μ-intro-μ'-imino-dicobaltic-bromide which along with *d* and *l* forms, yielded a meso variety incapable of resolution. The phenomena of racemisation and mutarotation which have both been observed with active inorganic compounds, have not found lucid explanation and still await further work.

No comprehensive work has been done on the influence of solvents on the rotation co-ordinated compounds and work leading to a decision on the applicability of Landolt-Oudeman's Law to them is certainly desirable. Jaeger (1915) who examined their rotatory dispersion found that the form of the dispersion curve is dependent on the colour of the solution and chiefly on the complex.

But for some work by Werner, the phenomenon of Walden Inversion has been little studied in this group. The theories advanced for inversion of organic compounds may not be applicable here due to their octahedral structure and the absence of double bonds.

The phenomenon of geometrical inversion which has engaged the attention of Dr. Neogi in recent years has been dealt with at length and is met with in two forms in the inorganic group : (1) ordinary cis-trans, transformation ; (2) inversion in which there is a transference of radicals from inside the co-ordination to the outside and *vice versa*. The latter form of inversion is so characteristic of these compounds that Dr. Neogi proposes for it a new name—Werner Inversion—and has undertaken to deal with it in greater detail elsewhere.

It is not generally known that the trophy for the highest specific and molecular rotations lies with the inorganic compounds, the values for *l* dodecammino-hexol-tetracobaltic bromide being —4500° and —45,000° respectively. There are still many gaps in the study of optical isomerism in inorganic compounds and Professor Neogi invites the votaries of both the branches of chemistry to the task of completing the work which was started so ably by the immortal Alfred Werner.

B. S.

GEOLOGY :

PROF. N. P. GANDHI's address deals with two topics of great interest to geologists as well as to workers in other branches of science. After indicating the aims and objects of pure geology, its cultural value is brought out with special reference to classical hypotheses like those of Hutton and Playfair. The 'contacts' of geology with other branches of science and the additions to knowledge accrued thereby are exemplified by the controversies regarding the age of the earth and the nature of its interior. The neglect of geology by Indian Universities is inexplicable particularly when considering that geologists can carry out very valuable work either in industrial concerns or in Universities. Effective remedies are suggested for securing due recognition to geology in University curricula.

The second part of the address deals with the organization of Mineral Research in India. Instances are cited of international movements of minerals and mineral products which have resulted in 'overdevelopments' of minerals and this is characterized as waste—'physical waste of raw materials and equipment, economic waste, employment waste and social waste'. To remedy the defects in the mining industry of India a five-year plan is suggested to deal with industrial mineral research by an organization similar to that prevailing in America. Attempts should also be made to educate the public by supplying suitable information on various aspects of Indian geology in popular language, well illustrated and distributing them at a nominal cost. The address concludes with a strong appeal to focus public attention on the important and urgent questions relating to the mining industry of India.

MATHEMATICS AND PHYSICS :

DR. A. L. NARAYAN's address naturally concerns itself with recent developments in Spectroscopy, the subject to which Dr. Narayan and his co-workers have principally devoted themselves during the past several years. A wide range of topics has been surveyed, including vector coupling, vacuum spectroscopy, Hyperfine structure, Molecular structure and the Raman Effect. Application of Physics to the study of the heavenly bodies also comes in for particular mention ; the origin of the auroral green line and of some lines in the spectra of the corona and of the Nebulæ are discussed in this connection. The application of the Raman Effect to the verification of Boltzmann's law of distribution of the different states of energy of molecules and to an ocular demonstration of the dissociation of electrolytes is also dealt with.

Taking first the question of vector coupling in atomic spectra, the two extreme types, *viz.*, l-s and j-j coupling, are discussed, and the criteria available for distinguishing between these types, *viz.*, the positions of the energy levels, the intensities of the inter-combinations and the Zeeman Effect, are then detailed. It is recalled how in actual cases the coupling is mostly of an intermediate type so that a distinction according to one or the other of these extreme cases becomes well-nigh impossible. Expression is then given to the conviction that a study of some of the more complicated Spectra is bound to lead to further advances just as the study of simpler cases paved the way for some of the most important modern advances in Physics.

The next topic to be referred to is vacuum spectroscopy of the extreme ultra-violet and the importance of this to the study of the spectra of "stripped atoms" initiated by Millikan and Bowen. The method of using a grating at grazing

incidence developed by Siegbahn at Upsala for a study of very soft X-rays is then described. The best sources of radiation for work in this region are then examined and it is shown that the Geissler tube possesses many advantages. The hollow cathode method developed by Paschen and Schüler is also very convenient for this purpose as well as for hyperfine structure work.

Coming next to hyperfine structure, its significance for a study of the nucleus and isotopic constitution is mentioned. The work of Hargreaves, Hill, Back and Goudsmit is discussed and in view of the paucity of the present data and the divergences between various workers, the necessity for much further investigation is pointed out. Details are then given of the systematic study of the arc spectra of Thallium and Indium and the spark spectra of Arsenic and Bromine by Dr. Narayan and Rao. The source was a cooled cathode arc of the type described by Venkatesachar and used by him in this line of work. The hyperfine structures were examined by means of quartz and glass Lummer plates and fused silica etalons. The results differed from those of McLennan and Crawford as regards the number of components and the existence of isotope shift in the lines 5351 and 3776 of Thallium. An extra component which has no place in the level scheme was also found in 3776. Results of an investigation of the hyperfine structure of the spark spectrum of Arsenic are also given and show deviations from those of Tolansky.

Touching next on the intensities of spectral lines, the rules governing the intensity relations in multiplets are alluded to and an attempt to compare these relations in emission spectra with those obtaining in the Solar spectrum using the lines of Nickel is then described. The results show that stronger lines appear relatively much stronger, in contradiction to the conclusion of Woolley that weaker lines appear relatively stronger.

Saha's theory of thermal ionization is discussed and its success in clearing up a number of problems in Astrophysics is pointed out. This leads then to the mechanism of the chromosphere and of the prominences on the sun's limb. Photographs of the prominences in K and Hα light were found by Royds to be nearly identical and this is shown to necessitate a revision of the present ideas of the mechanism of these prominences.

The problem presented by the green line in the spectrum of the Aurora and the Night Sky is then referred to and McLennan and Shrum's interpretation of it as due to a transition from the metastable $^1D_2$ to the $^1S_0$ state of oxygen and their production of the entire auroral spectrum by means of a discharge in a mixture of oxygen and the rare gases are described. The fact that whereas Lord Rayleigh and McLennan found that the intensity of the green line in the spectrum of the night sky reached a maximum about an hour after midnight, Ramanathan found it to be the reverse, is mentioned as likely to throw much light on the structure of the upper atmosphere in our latitudes.

Regarding the spectrum of nebulæ the interpretation of the lines 7325, 6584, 6548, 5007, 4959, 4363, 3726, 3729, as $^2D_{23} - ^2P_{12}$ (O II), $^3\bar{P}_2 - ^1D_2$ (N II), $^3\bar{P}_1 - ^1D_2$ (N III), $^3\bar{P}_2 - ^1D_2$ (O III), $^3\bar{P}_1 - ^1D_2$(O III), $^1D - ^1S_0$ (O III) $^4\bar{S}_2 - ^2D_3$(O II), $^4\bar{S}_2 - ^2D_2$ (O II) respectively, finds mention and Hopfield's production of the lines 6300 and 6364 is noted as the only successful attempt to produce nebular lines in the laboratory. The origin of the coronal lines is also yet obscure but a hope is expressed that it may be elucidated in the near future.

Next dealing with molecular spectra, Dr. Narayan notices the advances made during the last few years, the importance of the aid rendered by the study of the Raman Effect to a knowledge of molecular structure and the success of the new quantum mechanics in predicting the half integral numbers involved in band spectra, and the transition rules in molecular spectra.

The proof of the Boltzmann law of distribution of energy states from a study of the intensities of the Stokes and anti-Stokes lines in the Raman Effect is then dealt with. The initial qualitative results of Raman and Krishnan in CCl_4 and the later quantitative work of Ornstein and Rekveld are mentioned as providing a proof of the correctness of Boltzmann's law. The address concludes by referring to the work of K. R. Rao on the changes in the intensity of the Raman lines of electrolytes with increasing dilution, and that of Bhagavantam on the spin of the photon carried out in Raman's laboratory.

T. S. S.

MEDICAL AND VETERINARY RESEARCH:

IN the course of his address Lt.-Col. A. D. Stewart dwells first on the recent recognition of Preventive medicine as a branch of general science. He then proceeds to consider the place of Scientific medicine in human life.

"Medicine was first associated with religion which allowed of its rapid development in the earlier stages but stifled independent speculation and investigation and experiment. Later, medicine broke the bonds of doctrine and dogma; the names of Harvey, Koch, Manson, Ross and Ehrlich are some of the names associated with brilliant experimentation. But the real human touch and sympathy which brought medical science close to the human race was due to the combination of Harvey, the experimentalist, Chadwick, the legislator and Wesley, the humanitarian. Since then the boundaries of medical science have been tremendously widened. 'Man is a personality and an entity—the combination of body, mind and spirit.' The conception of health now is to envisage the full development of these powers, physical, mental and spiritual of which man is possessed. The development of our modern conception of public health is logical; care of the body first, then mind and then spirit."

"We are realizing now the importance of studying the mind. The Alderian doctrine of reaction to environment—occupational, social and sexual, has made us realize some of the problems of affection of the mind."

"Hygiene and other euthenic measures have prolonged the average length of life in many countries and it must be emphasized that the expectation of life does not merely mean that of body but also of mental powers. Medicine and science are beginning to make a profound appeal—aesthetic and religious—to thinking

people; the care and the development of the spirit is for future of these sciences. Man is mortal, and he feels disappointed with the shortness of his existence. Goethe wrote very truly, 'The spectacle of nature is always new, for she is always renewing the spectators. Life is her most exquisite invention and death her expert contrivance to get plenty of Life.' The only real objection is to premature death, so distressingly common."

"To the question that the thinking man puts himself regarding the purpose of life, my own answer is that in the quest and appreciation of truth and beauty, in their largest sense and meaning, is the best answer to life's purpose,—the one that gives the greatest satisfaction. Einstein says, 'To ponder interminably over the reason for one's own existence or the meaning of life in general seems from an objective point of view to be mere folly; and yet everyone has ideals by which he guides his aspirations and judgment. The ideals which have always shown before me and fitted me with the joy of living are Goodness, Beauty and Truth.'

"Formal religion has not satisfied the thinking man, and for the pursuit of truth, we look to science; but it is the poet who helps us most in our appreciation and search of the beautiful. Two medical men who later became poets, *i.e.*, John Keats and Robert Bridges have given the most notable contributions to the English language exemplifying the eternal principle of truth and beauty in life. Keats wrote, 'A thing of beauty is a joy for ever'; and 'Beauty is truth, truth beauty.' Bridges at the age of 86 wrote the 'Testament of Beauty'; he was a qualified doctor."

"Symbiosis and parasitism are two natural processes which have immense significance for the public health worker. True symbiosis is progressive, as it leads to the mutual aid. Parasitism is a degrading influence, injurious to the host, later possibly leading to death of the host. Parasitism is the chief obstacle in man's onward progress; obliteration of human parasites in India will be for some time the main task of the public health worker. It may be possible for man at some future date by evolving his mind and personality so as to obtain control of the genes in his chromosomes to produce human beings with finer minds and better-built bodies, but this is for the future. The immediate task is abolition of parasitism."

"The instinct for desire for truth and beauty is inherent in everyone, the medical man has got great advantages as his profession leads him to study nature and man. Planck, the celebrated Physicist, considers that the study of nature fosters the two noblest of impulses of human mind—enthusiasm and reverence. Our strongest response to nature when we listen to the 'still sad music of humanity' is to awaken the sense of pity with human aspirations, human suffering and human needs."

"Pity is one of the strongest forces behind public health work and preventive medicine. It has, however, the defect of its qualities. Pity is of its nature combative, it may outrun discretion and reason, and have an un-reasoning contempt for consequences and counting of costs. It may engender a spirit of recklessness, impatience of opposition and even fanaticism and ruthlessness. The essence of pity is unselfishness and sacrifice and in the hygienist these are necessary qualities."

"The life of a medical man is one of curiosity and in some this may be extremely highly developed and the search for truth becomes a passion and a purpose. Research needs a natural urge and aptitude, a long apprenticeship in technique, untiring industry, the highest self-criticism and above all the passion for beauty."

"Another quality the public health worker needs is courage—courage born of belief and faith in one's work."

"Education, guidance and more co-operation between the public and the medical profession are some of the modern trends of public health. There is a growing feeling that in public health policy, too much compulsion is undesirable and should be kept rather for times of emergencies and extraordinary danger. Indifference, ignorance and conservatism and the idea that health is the affair of the sanitarian, are definite handicaps to the health workers."

"A free and honest discussion on the population problem on the following lines would help greatly:—

1. Are numbers alone the cause of general economical stress?
2. How far the methods of population restriction alone be the cause of population adjustment?
3. Should the State give facilities for instructing the public in methods of birth-control for:—
   (*a*) medical reasons;
   (*b*) general economic reasons.
4. What would be the effects of (*b*) alone on the rural masses of India?

"The idea of population restriction seems to be based on the apprehension of the increase of the so-called lower classes or races and the desire for security is from the self-preserving instinct. We should remember our stability is but balance and conduct and lies in masterful administration of the unforeseen."

"I have indicated what I consider should be the attitude of the medical man and the public health worker towards the science and his work. A constant desire for truth, an appreciation of the beautiful and of the essential of the realities and unity of these two; a spirit of sympathy and pity for the human race; continuous assiduity in the alleviation and prevention of disease; a belief in the possibility of upward progress of mankind through evolution controlled by intelligence, and in the application of the ideals of preventive and constructive medicine in the development of man's higher attributes, a spirit of conviction and courage in the face of difficulties."

C. V. N.

PSYCHOLOGY.

DR. GIRINDRASEKHAR BOSE, the pioneer of the psycho-analytical movement in India, has made a distinctive contribution to our understanding of the human mind, in the course of his Presidential Address to the Psychology Section of the Indian Science Congress, of 1933. Dr. Bose has given us a new theory of Mind which may be briefly referred to as the theory of the *Opposite Wish.*

As the theory has gradually evolved in his mind in the course of his work along Freudian lines, we may be permitted to briefly state the fundamentals of the Freudian system, to begin with. Prof. Sigm. Freud traces all mental derangement to repressed wishes chiefly of an infantile sexual character, which try to act in an autonomous way from the unconscious mind. Once they are brought up to consciousness they are supposed to yield to reason and persuasion, and lose their irrational and morbid character. These unconscious infantile sexual cravings tend to express themselves in various ways, such as dreams, phantasies, errors and slips of the tongue and pen, accidents, outbursts of temper, humourous sallies, crimes, etc. The ego is supposed to exercise the censoring influence on all unconscious dynamic mental contents. Merely bringing back to consciousness of an unconscious wish does not affect a cure, the emotions attached to the unconscious desire should be *lived* over again. The above in brief is the orthodox Freudian position. Let us now set forth the departure from this proposed by Dr. Bose.

Dr. Bose observed, in the course of his extensive practice in Calcutta, certain phenomena which appear to have been overlooked by the Freudians in the Western countries. He noticed that the symptoms of mental derangement, do not disappear even when the patient has accepted the truth of the physician's psychoanalytic interpretation. On the other hand, he noticed a curious transformation in the symptoms, which leads one to suppose that every wish in the unconscious is accompanied by its opposite. The nature of the symptoms changed in such a manner as to indicate the operation of the Opposite of the original wish. As the analysis proceeded, the opposite wish comes into the conscious mind and the primary repressed material loses its significance. When in turn the Primary wish is brought to consciousness again, the Opposite wish would similarly lapse into the Unconscious. Dr. Bose found that this *See-saw mechanism* as he calls it, goes on with striking regularity, but with a gradually decreasing intensity of the Opposite tendency, and an increasing frequency of oscillation, till a time comes in the course of the treatment, when both the Primary and the Opposite wishes would simultaneously emerge into consciousness —and it was only then, that a real and complete cure is effected by the Psycho-analytic procedure; all other cures aim only at the symptoms and not at the causes underlying the derangement.

According to Dr. Bose's new theory of the Opposite wish there is no need to postulate the mysterious Censor, who is supposed to keep guard at the threshold of consciousness. The theory of the Opposite wish explains all the facts of repression, mental conflict, in a simpler manner than the doubtful structure built up by the Freudian school, which need to be propped at many points by special arguments. Identification, Projection and Reversal, which are usually supposed to be Primary activities of the ego, defying further analysis, can be understood in simpler terms, if we accept Dr. Bose's theory of the Opposite wish. His theory in short does away with the multiplicity of formulations invented *ad hoc* to explain away special difficulties.

We may congratulate Dr. Girindrasekhar Bose on the notable contribution he has made to our understanding of human nature.

M. V. G.

ZOOLOGY :

PROF. GOPALA AIYER, proficient as he is in this branch of biological study, and with his record of work round the British coast and in the Mediterranean Sea, is entitled to speak with authority on a matter, which has so far received only very scanty attention in India. Unfortunately, geographical and climatic conditions, the present financial position and probably also a certain apathy on the part of the Government and the people of India have together conspired against the fulfilment of the ardent wish of the naturalist in India, the exploration of the Indian marine resources.

Prof. Gopala Aiyer begins with a very illuminating account of the history of the growth of marine biological research in Europe. The pioneer work of the famous expeditions of the "Challenger", "Albatross", "Michael Sars", "Discovery" and others has added not a little to our knowledge of the conditions of deep sea. The first point of importance that has emerged out of the untiring work of this noble band of naturalists in charge of these expeditions is the striking uniformity of the laws that govern life in the sea. The relationship that exists between marine animals and their medium is much more simple than that between land animals and their medium. Indeed the uniformity of composition of the aquatic medium has brought about this uniformity of structure of the organisms that live in it. It is probably this simple relation between marine animals and the sea that has made experimental biology such a success. But the marine investigator is faced with other problems of really great importance and difficulty, inherent in the medium on account of its constant movement resulting in a far from satisfactory knowledge of the fauna and flora of the sea.

The problem of the food of the countless myriads of organisms found in the sea is the first that attracts our attention and for which an effective solution is offered by the plankton. Numerous workers have unanimously affirmed that plankton which consists mainly of Diatoms and Copepods offers the staple food of marine organisms. A seasonal variation in its occurrence is one of the main characters of plankton and various explanations are given for this. Probably like all natural laws this one also is based on a very fine adjustment of environmental conditions. But a far more striking feature of plankton is its abundance in colder seas and its relative rarity in tropical waters. Though several explanations are offered to account for this phenomenon, it is probably true that in case of waters with an abundance of nitrate food and other nutrient salts, plankton is also abundant. While, however, tropical plankton is rich in species, that of the arctic and antarctic waters is rich in individuals. This is probably due to the more sustaining nature of the colder waters due to a reduced rate of metabolism.

The relation between environmental conditions and life's processes is at once clear an

mysterious. It is a matter of common knowledge that increase in temperature means increased rate of metabolism, which, in itself, acts as a powerful inhibitor of growth in size. This is probably why larger animals abound in the colder seas. Indeed, various aspects of life-history, growth and development, reproduction of animals and their distribution, all show a very curious correlation with changes in temperature. Probably second only to temperature comes sunlight. The bearing of this factor on life in the sea is one of supreme importance and indeed is the factor that governs the vertical distribution of animals. However, the fact that plankton is to a great extent dependent on sunlight is admitted. And when we realize the intimate relations between plankton and the larger forms of life in the sea, the importance of sunlight as a governing factor of life becomes at once obvious. But there exists a whole host of animals far down in the dark leaden depths of the ocean where hardly any light penetrates, whose life is one great and continuous uniformity. How profoundly these animals differ from the surface forms in structure, in bionomics, in behaviour and in development is a matter of common knowledge. While salinity is a factor far less important than either temperature or sunlight on account of its comparative changelessness, it is near the coastal lines that any deviations may occur, due to the encroachment of fresh waters. And consequently it is these shore animals that have adapted themselves to a certain extent to the changing salinity of the medium. Further than this, salinity is incapable of acting as a guiding factor of life in the ocean.

The problem of the sea-shore is of such importance that literature on this aspect of marine biology is growing rapidly. The sea-shore combines such a variety of physical and biological factors and with such regularity that it has been rightly called the hot bed of evolution.

Prof. Aiyer makes no mention of the life at the sea bottom, the animals of the abyss, the enormous number of factors that governs the lives of these animals, their apparently changeless but extremely interesting environment, their form and size, their distinctions and peculiarities. But probably this is the most difficult aspect of the research of the sea, characterized by danger and fallacious argument.

Prof. Aiyer concludes his admirable summary of life in the sea with a very vigorous plea for an all-India marine biological station and suggests, very rightly, Pamban as an ideal place for such a station. The need for such a station is admitted but it is the great factor of co-operation that is required in India to-day to make this need an accomplished fact.

B. R. S.

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Letters to the Editor.

Observations on *Tolyposporium penicillariæ* Bref. (The Bajri Smut Fungus).

A SMUT disease has long been known to occur on Bajri (*Pennisetum typhoideum* Rich.), one of the staple crops of Gujarat and, although in ordinary years it does not cause serious loss, in wet years the damage to the crop may be appreciable.

Beyond the identification of the causal fungus and the observation that the germination of the spore-balls is "scanty and difficult"[1] no work had been done on this disease until 1930 when one of the writers of this note (S.L.A.) reported the successful germination of the spore-balls readily taking place on several artificial media.[2] Since that time the disease has been further studied jointly by the writers at Ahmedabad and Baroda. The fungus has been studied in the field and in the laboratory and inoculation experiments have been carried out.

The main conclusions reached so far in this work are summarised below:—

(1) The fungus can be easily cultivated by sowing spore-balls on corn meal, Bajri meal and Jowar meal agar, and on boiled potato and boiled carrot. The sporidia multiply indefinitely by budding on these media. Very little mycelium is formed on any of the media tried and the growth consists almost entirely of sporidia.

Cultures of the fungus were also easily obtained by aseptically opening unripe, green-affected grains and suspending the whole mass of white mycelial ball found within on malt-agar slants.

(2) Infection takes place at the flowering stage of the host as in wheat, but no dormant mycelium in the infected grains is formed in the case of Bajri smut, the infection being followed in about two weeks from the date of inoculation by the formation of spore-balls.

(3) No other part of the host plant seems to be vulnerable to the attack of the fungus, though in one case the inoculation experiments carried out at Ahmedabad suggest the possibility of successful wound infection through pin pricks of the shoot. In any case, no part of the host plant, other than the grain, developes the spore-balls. Many grains in an affected ear escape infection. Even in the same spikelet one grain may be affected while the rest remain healthy.

(4) Microscopic study of the affected grains in various stages of development has shown that the fungus occupies the space between the pericarp and the aleurone layer and forms its spore-balls after gradually exhausting the starchy endosperm. In the beginning a peculiar white mycelium is found to exist in the affected grain. The nuclei in this mycelium are long, streak-like. The dark chlamydospore-balls are developed at the cost of this mycelium.

(5) Contrary to what has been previously believed[3], no resting period is necessary for the spore-balls to germinate at least on artificial media.

(6) Seed treatment with copper sulphate and sulphur is entirely unsuccessful in the case of this smut.

(7) None of the common varieties of Bajri is immune to this disease.

(8) The attack of the disease is more severe in wet seasons than in dry ones and more severe in those ears which come out during wet weather than in those which come out in dry weather. The later ears (formed when the weather is dry) even on plants which had earlier shown the disease have been found to have escaped the disease. This points to the possibility of dodging the disease by adjustment of the sowing date and by selection of late varieties.

The source of infection of the first grains in any season is still a mystery, for, although the spore-balls have been ascertained to retain their germinating capacity for at least two years, they have not been so far found to germinate except on artificial media. A close study of the behaviour of the spore-balls as they lie in the soil and also of weed grasses in Bajri fields as possible alternate hosts for the fungus may lead to the solution of this mystery.

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V. N. LIKHITE.
Research Laboratory,
Agricultural Experimental Station,
Baroda.

November 22, 1932.

[1] Butler, E. J., *Fungi and Disease in Plants*, p. 225.

[2] Ajrekar, S. L., *Proc. Ind. Sci. Congress, Bot. Sec.*, 1931.

[3] Butler, E. J., *Fungi and Disease in Plants*, p. 226.

Liverworts and Fern Sporophytes.

DURING the last week of August of this year, I collected some liverwort material in Landour, Mussourie, in the north-west Himalayas. On examination, after it was brought to Lucknow, some young fern sporophytes were found among the Liverworts. The sporophytes were still attached to the prothallus and on the underside of the young sporophyte leaf, sporangia were found as shown in the accompanying sketch (Fig. 1).

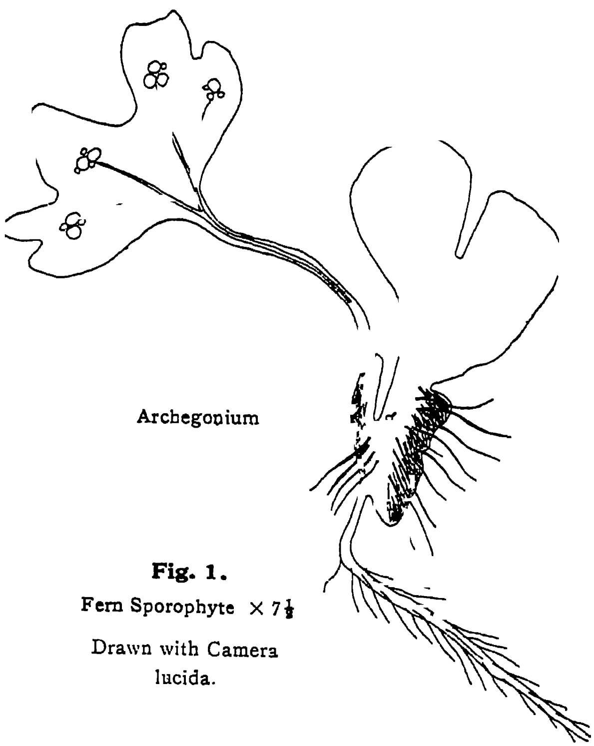


Fig. 1.
Fern Sporophyte × 7½
Drawn with Camera lucida.

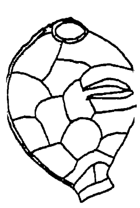


Fig. 2. × 55
Sporangium
Drawn with Camera lucida

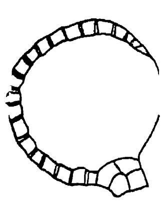


Fig. 3. × 55
Side View: Sporangium
Drawn with Camera lucida

Some of the sporangia were black, indicating maturity and the spores (Fig. 4) were sown in an attempt to germinate them, but they failed to do so.

Fig. 4.
×110
Single Spore

The sori were without indusium and consisted of sporangia of different sizes, indicating their position in the Mixtæ or Gradatæ of Bower. It is also noted that the sporangia have a very short stalk and vertical annulus (Figs. 2 and 3).

The prothallus appears to consist of two parts, a bulbous one which bears rhizoids and sex organs (one archegonium was found as shown in Fig. 1), and the usual heart-shaped leaf-like structure, which has a different cellular structure from that of the sporophyte leaf and no vascular tissue, which would indicate that it is part of a prothallus.

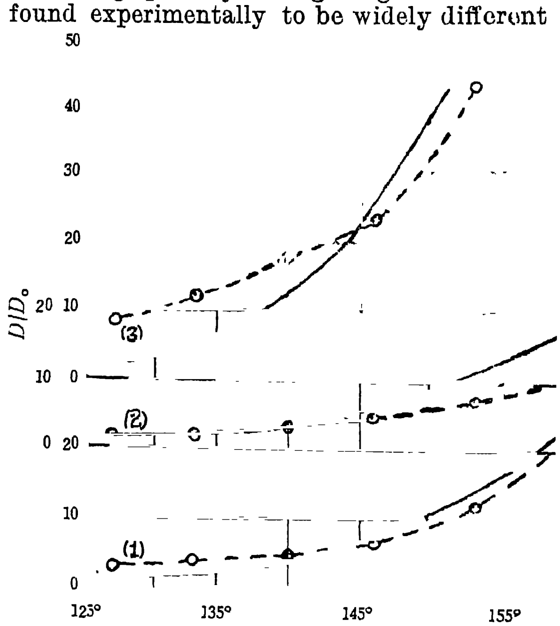
Since spore-formation is associated with the mature sporophyte plant, these specimens seem worthy of note.

R. H. OLDROYD.

Isabella Thoburn College,
Lucknow,
November 15, 1932.

The Wave Statistical Theory of the Anomalous Scattering of α-Particles.

THE recent experiments of Bieler, Chadwick and others have created a considerable interest in the subject of anomalous scattering of α-Particles. The intensity of scattering specially at large angles has been found experimentally to be widely different



Angle of Scattering in degrees.

(1) Carbon. (2) Boron. (3) Beryllium.

from that given by the inverse square law. Of late, A. C. Banerjee (*Phil. Mag.*, **9**, 273, . 1930) has extended Wentzel's wave mechanical method by taking a polarisation force varying as $1/r^3$ and has obtained a formula which only partially agrees with Bieler's experimental values for Aluminium and Magnesium. This formula, it may also be remarked, fails to explain the very high values of scattering for the lighter elements, *e.g.*, Carbon, Boron and Beryllium as recently observed by Chadwick (*Proc. Royal Society*, **134**, 154–170, 1931). Very recently Taylor (*Proc. Royal Society*, **136**, 605, 1932) has also given a theory of scattering by Hydrogen and Helium. But as he himself admits, his method is not applicable to elements other than the above.

In a paper which is in progress I have derived on the basis of a polarisation force varying as $1/r^5$, the following formula:—

$$D/D_0 = \left\{ 1 - \frac{\frac{4\pi^2 r_0^2}{\lambda^2} \operatorname{Sin}^2 \theta/_2}{\operatorname{Cos}\left(\frac{4\pi r_0}{\lambda} \operatorname{Sin} \theta/_2\right)} \right\}^2$$

It is in good agreement even with the recent experiment of Chadwick as is evident from the figure where the curves obtained from the above formula are drawn continuous.

K. K MUKHERJEE.

Serampore College,
Serampore, Bengal, India,
November, 1932.

The Water Resistance of Shellac.

THE water resistance of a shellac varnish film is not good and detracts from its value for certain uses. The possibility of improving this property has been examined in this laboratory.

Amongst the works previously published on this subject that of Paisley (*J. Ind. Eng. Chem.*, **24**, 2, 163) is of importance. He describes the marked improvement in the water resistance of "bleached shellac" varnish films produced by inclusion of 10% tricresyl phosphate. Repetition of this work with pure "unbleached' shellac has shown, however, that the effect of tricresyl phosphate on this type of varnish is small. No improvement was found in the liability to flushing and the amount of water absorbed; although the cracking produced by rapidly drying the film was considerably less in the plasticised film.

Marked improvement in water resistance of baked shellac films has been observed and optimum conditions of time and temperature investigated.

The effect of such modification as addition of plasticiser and baking on other properties of shellac films has also been examined.

It is hoped that a paper describing this work will shortly be published.

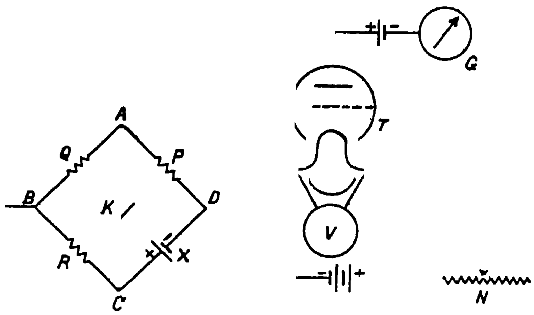
R. W. ALDIS.
M. RANGASWAMI.

Indian Lac Research Institute,
Namkum,
October 28th, 1932.

Application of the Thermionic Valve to the Measurement of Battery Resistance.

IN Mance's method for the measurement of battery resistance the current that passes through the galvanometer all the time produces a deflection right off the scale. Various suggestions, such as the use of a controlling magnet, an auxiliary current, a differential galvanometer, etc., have been made to get over the difficulty. In Lodge's modification of the method a condenser is used in series with a ballistic galvanometer. In the following notes is described an arrangement in which a thermionic valve is used to avoid the difficulty stated above.

The details of the arrangement are indicated in the following diagram:—



P, Q and R are the three arms of a Wheatstone's bridge, X is the cell of which the resistance is to be measured. K is a make-and-break key. T is a thermionic valve, the valve used being one of Marconi type D.E.3. V and N are voltmeter and rheostat to regulate the filament current. G is any ordinary galvanometer. There are two accumulators in the filament circuit and one in the galvanometer circuit.

When the circuit is completed (K remaining open) the initial current which passes

through the galvanometer is not, ordinarily, strong enough to deflect the spot of light off the scale; and even if it is found to be the case the spot can be easily brought back on the scale by increasing the resistance N of the filament circuit. The arrangement is found to be quite sensitive. On completing the circuit at K the spot moves from its position of steady deflection through an appreciable number of divisions of the scale even for a slight lack of balance of the bridge.

The resistances of a few cells were measured by (A) Mance's method as well as by (B) the modified arrangement detailed above. The results are given below. The tests were carried out using solutions of zinc sulphate and ammonium chloride of different strengths on different dates. It will be found that the results obtained by the two methods fairly agree.

RESULTS.

Resistance of one Daniell's Cell (in Ohms.)

Method A ..	0.78	1.12	1.30	1.43	1.44
Method B ..	0.80	1.13	1.30	1.43	1.50

Resistance of one Leclanche's Cell (in Ohms.)

Method A ..	0.70	1.00	1.90	3.20	3.20
Method B ..	0.70	1.00	1.90	3.15	3.20

R. C. SEN.

Physics Department,
G.B.B. College, Muzaffarpur,
May 10th, 1932.

Research Notes.

Halogen Compounds of the Rare Gases.

ONE of the most interesting communications that have appeared in the chemical publications of the last few months is that made by Antropoff, Weil and Frauenhoff (*Naturwissenschaften*, **20**, 688, 1932). Starting from the generally accepted assumption that the valency of an atom depends upon its tendency to have only eight electrons in the outermost "shell", these workers concluded that the rare gases need not necessarily have zero valency; they could as well be octavalent (helium divalent). It was thus expected that especially the heavier of the rare gases could form compounds above all with the halogens.

The experimental arrangement was roughly as follows:—A mercury pump is arranged to send crypton gas through a series of glass tubes through which electrical discharges of high intensity can be sent and also through some bulbs cooled by liquid air. The pressure of the crypton varied between 5 to 1 mm., and as its vapour pressure at the temperature of the liquid air is 17 mm. the crypton does not condense. In the discharge tube, the crypton was mixed with chlorine, which is again removed from the mixture by freezing, when it passes through the cooled bulbs. A MacLeod manometer was used for measuring pressures.

It was seen that as soon as the electric current was switched on, the gas-pressure was observed to sink to as much as half its value in 10 minutes. This diminution in pressure is also obtained with crypton and bromine, but not with argon and chlorine nor when the crypton-chlorine mixture is not subjected to the electric discharge. The only explanation which would explain this diminution of pressure is that a compound between the crypton and the halogen is formed and condensed by the liquid air. Moreover, a dark red substance was always observed in the freezing bulb whenever and only when a diminution of pressure took place and it was seen to be much more volatile than chlorine and possesses a band-spectrum. It can even be made to react with calcium, the reaction being violent, and the remaining gas shows then the pure spectrum of crypton.

Curiously enough, this crypton chloride seems to be quite a stable body, and the gas obtained from the above-mentioned red body, after standing for a number of days at room temperature, can again be condensed to the same red coloured substance. Even in contact with hot mercury, the rate of decomposition is very slow.

One can scarcely over-state the case if one says that Professor Antropoff and his colleagues in Bonn have made here an epoch-making discovery and if their observations are verified by other independent observers, they will constitute one of the most important supports for the Bohr-Rutherford atom.

The Inheritance by an Insect Vector of the Ability to Transmit a Plant Virus.

[Storey, H. H., *Proc. Roy. Soc.*, B, **112**, 4(
(1932).]

THE possibility of having unequal ability tc transmit a virus by the different races of ք

species was suggested several years ago; but Dr. Storey working on the races of *Cicudulinambila* and the virus of streak disease of maize has experimentally demonstrated that it is actually so. He further states that the ability to transmit the virus is inherited as simple dominant Mendelian factor, linked with sex.

Experimental Distortion of Development in Amphibian Tadpoles. Pt. II.

[Sladden, D. E., *Proc. Roy. Soc.*, B, **113**, (1932).]

FROM observations made on a large series of experiments of various kinds involving the rearing of many thousands of frog tadpoles, the author concludes that apart from action of sugar or pH variation there is another factor which has a fundamental influence on the developing eggs of these animals. This unknown factor, according to the author, comes into play as a result of overcrowded conditions. Under these conditions the oxygen content of the water is reduced while the amount of CO_2 and nitrogenous products are automatically increased. The greatest number of abnormalities occur among those animals which are most weakened through lack of food and oxygen.

Carotinoid Colour Substances of Fishes.

LONNBERG (*Arkiv: for Zoologi*, **23A**, Hafte 4, 1932) has determined the nature of the colour substance of fishes by chémical tests, especially with the aid of antimony chloride and has come to the conclusion that the so-called lipochromes of fishes are really carotinoids. A large number and variety of fishes have been examined, and a comparative account of the respective spectra of the carotinoids reveals that the colour solution of the majority of them cannot be fractioned and must therefore be unitary. And in many cases the carotinoids belong to the xanthophyll group and this is of great interest as many of the marine invertebrates which serve them as food belong to the carotine group.

The Age of a Monazite Crystal.

[Fenner, C.N., *Amer. Jour. Sci.*, **136,** 1932.]

FENNER'S contribution is of special interest in view of the growing possibilities of being able to determine geological ages by calculations based on the principles of atomic disintegration of radio-active elements. The uranium, thorium and lead contents of the monazite crystal have been determined and on the supposition that the lead has been derived from thorium by radio-active disintegration, an age of 277,900,000 years is calculated. Seeing that this result agrees very closely with the age of an uraninite from the same quarry determined several years ago as 282,900,000 years by W. F. Hillebrand, it will be obvious that the fundamental principle involved in this method of calculating the age of radio-active minerals is essentially sound and reliable.

Notes on some early Blastocysts of the South American Bat,—Molossus.

[G. S. Sansom, *P.Z.S.*, Part I, March 1932, pp. 113-118.]

THE early development of Molossus agrees fairly closely with that of the other Micro-Cheiroptera. The orientation of the blastocyst at right angles to the mesometrial axis is noteworthy; it occurs in all the six early stages, but is not preserved in the last, considerably later blastocyst, where the embryonal disc is directed more towards antimesometrial side. The primitive amniotic cavity arises as a cleft in the amnio-ectodermal mass and its formation is apparently initiated by the rearrangement of the cells. The roof of this cavity thins out and ultimately disappears with the result that a cavity is formed bounded on the one side by the shield ectoderm and on the other by the thin layer of covering trophoblast. The definite amniotic cavity is formed by the ingrowth of ectoderm from the margins of the ectodermal shield in contact with the covering trophoblast. The slight activity of the cytotrophoblast and the apparent absence of syncytiotrophoblast even in the latest stage described are noteworthy. The trophoblast in these early stages appears to be devoid of phagocytic or cystolytic properties.

The Genus Hyracotherium.

THE European and American genera of Eocene horses have been subjected to a revision in an interesting paper (*Phil. Trans.*, 1932, **B 221,** 481) by C. Forster Cooper. The prevailing practice is to give the American forms the name Eohippus and the European forms Hyracotherium, Propachy-

nolophus and Pachynolophus and there is a difference of opinion whether Hyracotherium differs from Eohippus or not. Cooper after examining the material contained in the British Museum, the Royal College of Surgeons, the American Museum, the casts of Pachynolophus and Propachynolophus from the University of Lyons and the Cambridge specimens in the collection of the Sedgewick Museum, has come to the conclusion that all the specimens of Eocene horses discovered in Britain constitute a single genus Hyracotherium comprising three species, H. cuniculus, H. leporinum and H. vulpiceps. The forms Hyracotherium and Eohippus present more points of similarity than difference and the distinction hitherto drawn between them is untenable. Judged from the dental characteristics, Hyracotherium cannot be considered as more primitive than Eohippus, the species of the former belong to the same stage of evolution as those of the latter. No distinction can be drawn between the European form Propachynolophus and the British genus Hyracotherium and some forms of Pachynolophus are hardly distinguishable from the latter.

Thalamic Connections in the Rat.

THE experimental study of thalamic connections in the rat by W. E. Le Gros Clark (*Phil. Trans.*, 1932, **B 222.** 483) has given some extremely interesting results having a bearing on the interpretation and significance of the different nuclear centres in the optic thalamus. The relations of the nuclear centres to the cerebral cortex and with other parts of the brain studied by Marchi technique offer interesting points of phylogenetic importance. It is found that the more dorsal and lateral parts of the ventral nucleus have fibrous relations with the dorsal area of the parietal region of the general sensory cortex and the ventral aspect of the nucleus ventralis being connected with the ventral and medial parts of the same sensory and insular areas. Thus the fibres take a definite route to the cortex. No thalamo-cortical fibres from the medial ventral nucleus could be traced in the rat but the degenerate fibres traceable from the site of lesion suggest that they are thalamo-striate in nature. The nucleus medialis ventralis is regarded as homologous with the nucleus rotundus of reptilian diencephalon because of the topographical relations and the connections of the nucleus in both cases with corpus striatum. In the evolution of mammals it is significant that the medioventral nucleus so well defined in the primitive forms gradually becomes indistinct till it is finally lost in the primates. The studies of Clark lend evidence in support of Edinger's con tention that there is a thalamo-mamillary component of the bundle of Vicq De-Azy besides the transverse connections of the two anterodorsal nuclei of the anterior group across commissura-inter-antero dorsalis. O the three elements composing the anterio group of nuclei, the antero-ventral one i connected with the whole area singu laris of the cortex by corticipetal fibres while the antero-medial nucleus provide no evidence of cortical connections bu has connections with the antero-ventra nucleus of its own group, the nucleu medialis ventralis and also with the nucle of periventricular system. No evidenc could be obtained for establishing cortica connections with antero-dorsal nucleus. O the three components forming the anterio group of nuclei the antero-medial one ma be regarded as representative of the palæc thalamus and evidence has been adduced t establish its derivation phylogeneticall from the nucleus dorso-medialis of th reptilian thalamus, a nucleus which is nc related to the somatic areas of the later part of the fore-brain. Regarding th lateral nucleus which comprises pars princ palis and pars posterior, the conclusion reached that the former is related b reciprocal fibre connections to the mo dorsal limit of the parietal area on tl lateral surface of neo-pallium close to tl median line,—this conclusion fits in wit the conception that the great expansion the main part of the lateral nucleus i higher mammals is associated directly wit the progressive elaboration of the pariet association areas in these forms. There no evidence to establish the corticifug connection of the pars posterior. Tl dorso-medial nucleus which is equivaler of the medial nucleus of the human brain regarded by certain authors as a palæo-thal. mic centre (which is really the antero-medi nucleus of the anterior group as has bee shown by Clark). In fact the nucle dorso-medialis is one of the recently develo ed thalamic elements and is not homologo with the nucleus dorso-medialis of reptili diencephalon. For this reason, it is desi able not to include it in the medial nucle group. The studies of Clark have still left

doubt whether the nucleus pretectalis is part of the thalamus, occupying as it does a position at the junction of the mid-brain and the diencephalon. There is evidence, however, that it has fibre connections with the posterior part of the parietal area of the cortex but not a corticipetal character. The system of the nuclei of the midline is formed by the descending fibres of the ganglia habenula and of the dorso-medial nucleus. From the evidence adduced by the researches of Clark, it appears that in the rat cortico-thalamic fibres terminate in all the principal nuclei of the thalamus with the exception of the nucleus antero-medialis, nucleus medialis-ventralis and the nuclei of the midline. In the higher mammals such connections are apparently very insignificant. The experiments on the rat show that corticotectal fibres arise from the occipital lobe of the cerebrum which is in accordance with the observations of previous authors. There is also evidence that in the rat all the principal nuclei of the thalamus proper send off projection fibres to the neopallium with the exception of antero-medial nucleus, nucleus medialis ventralis and nuclei of the midline. These are therefore the only thalamic elements which can be considered as homologous with the palæothalamus of great phylogenetic age.

An Analysis of Some Necrotic Virus Diseases of the Potato.

AN analysis of some necrotic virus diseases of the Potato forms the title of a valuable article by R. N. Salaman and F. C. Bawdan (*Proc. Roy. Soc.*, **B III**, 769, 1932) in which after giving full details of the previous works of the subject, the authors describe how our views on the virus diseases of plants have passed through the phase when protein reactions are mistaken for specific disease and given special names, *e.g.*, the leaf-drop streak which is known to be induced by one single virus and that virus is Kenneth Smith's Y. It is further known that Quanjer's top-necrosis is caused by different agents altogether. In limited number of varieties this disease can be produced by Kenneth Smith's X virus acting alone. The other varietal reactions are designated as Top-Necroses A, B & C. Top Necrosis A is shown to be caused by a complex of both X and Y possibly associated with virus Z. Top Necrosis B is likewise due to a complex containing both Z and Y. Top Necrosis C is caused by both X and Y. Top Necroses X and C complexes are transferable to other Potato varieties by needle inoculation. Top Necroses A and B are uninoculable except that A can be conveyed to varieties like Arran Crest and Epicure, by needles. Top Necrosis A is found among the widest grown varieties such as the Arran Banner, Majestic and Up-To-Date, a fact that leads to this consideration of practical and economic importance. Looked at from the pathologist's point of view, these carriers of virus are vast reservoirs of the most destructive of all the virus entities we know, dangers to other varieties and even a danger to themselves—for a carrier Up-to-Date can go down to a further infection of the very virus which it itself is carrying. The authors suggest a way out of the dilemma either by aiming at growing only virus-free stocks—a possible though difficult and costly task—or using only such varieties as are successful carriers of the more serious virus diseases.

A Scheme for Advancing Scientific Research in India.

By Hem Singh Pruthi, D.SC.

IN a recent issue of the *Current Science*[1] Prof. Gideon has put forward an elaborate scheme for the organization of research work in India. If I understand him right, the most important point he urges is that research in applied sciences like Agriculture, Medicine, etc., should not be restricted to a few central research institutions, but that some of the activities of such institutions should be retrenched and the teachers in the numerous mofussil colleges in the different provinces of India should be invited to work on research problems which have *direct* economic value from the Agricultural, Medical and Veterinary points of view. Only big university centres, according to him, should carry on research of purely academic nature. I request the hospitality of the columns of the *Current Science* for making some remarks on Prof. Gideon's scheme, especially in reference to research in entomology, admittedly the largest and most important section of economic zoology.

Presuming that there is enough justification for Prof. Gideon s statement that "the majority of mofussil colleges teaching science are free centres for research, having trained men with leisure for such work," it is very doubtful if they have well-equipped laboratories and libraries for doing research of direct economic value. A man working on the control of insect pests has often to consult literature not only on entomology but on several other sciences like Physiology, Biochemistry, etc. Few research workers will deny that small annual grants for the purchase of literature are in any way adequate and that frequent getting of books by post from a far off library hardly conduces to well-sustained and concentrated work. Nor does a short visit to a big library in the beginning or at the end of research work meet the needs, as literature has to be consulted simultaneously with the progress of work. Regarding the equipment of laboratories, the mofussil colleges will each at a time be able to undertake the study of one or two pests and the necessary apparatus, etc., required by several of them will often be similar. It will be readily understood that this multiplication of the same kind of apparatus in a province and the consequent considerable unnecessary expenses can be easily avoided if the study of all the pests is restricted to a few well-equipped central institutes in the province.

Moreover, the study of an insect pest is not purely an entomological problem in as much as when devising means of control careful account has to be taken of the general agricultural practices prevalent in the area. An Economic Entomologist therefore, has frequently to consult and remain in close touch with his colleagues in the sections of pure Agriculture, and other Agricultural Sciences.

The mofussil colleges, however, can d[o] very important research work of purel[y] academic nature and at the same time o[f] great indirect economic value. They ca[n] study the anatomy, life-history, habits an[d] ecology of insects, especially of the specie[s] which are harmful or beneficial to man a[t] the present time or are likely to be so i[n] future. They can easily ascertain th[e] names of such species from the Economi[c] Entomologist of their Province. First clas[s] research can be done on this aspect o[f] Entomology. This kind of work can b[e] done even at a comparatively isolated plac[e] without requiring much literature or ex[-]pensive apparatus. I think that it is for th[is] kind of research that the Imperial Counc[il] of Agricultural Research gives grants t[o] teachers in science colleges. It is the mo[st] essential work preliminary to the solution o[f] the problems of insect control which, as abov[e] explained, had much better be worked at [a] central institute or college. Needless to ad[d] that all the important universities in Ind[ia] or even in England recognize this kind o[f] research work as quite suitable for theses f[or] their research degrees.

Though the remarks made above ha[ve] special reference to Agricultural Entomolog[y] they apply with equal force to medical an[d] veterinary divisions of this science.

[1] *Current Science*, 1, 133, 1932.

9

Science News.

THE Presidential Address by Mr. K. Dutt recently (July 1932) delivered before the Geological, Mining and Metallurgical Society of India, Calcutta, deals with the very important question of fuel economy and problem of second class coal. He has discussed at some length how certain types of coal are simply run down in the coal market by being labelled 'second class' on meaningless considerations—attributing inefficiencies in the boiler solely to the alleged 'poor quality' of the coal. He concludes by saying "There need not be any *pariah* among Indian coal fuels. By scientific methods they can be all reclaimed; by mechanical equipment, it is possible to make them yield the same or almost the same quantity of steam that could be possibly obtained from the burning of the so-called selected grade of coal."

* * *

A course of training in Marine Biology was given to teachers from different parts of the Bombay Presidency at the Royal Institute of Science, Bombay. The training consisted of lectures in Zoology and practical work including collection and handling of animals from sea shore, plankton by townet and animals from deep sea by dredging and trawling. The course has proved highly popular and it is hoped that it would be possible to extend the facilities to teachers and post-graduate students from other parts of India as well.

* * *

The Convocation Address of the Hindu University of Benares was given by Pandit Madan Mohan Malaviya who spoke in Hindi, exhorting the graduates to lead a simple life distinguished by the rare purity which belongs to the Age of Rishis but virile with the zeal and the thoughts of modern age of scientific discoveries. The Address is a packed essence of patriotic fervour worthy of a great man and the great place where he spoke.

* * *

Sir Frank Noyce addressing the Muslim graduates of Aligarh University dwelt at length on the nature of the University education which should be imparted to the 'ordinary man'. To him the education that really matters in life is what remains after he had forgotten most of what he had learnt in the University. Sir Frank Noyce has given an admirable summary of knowledge in contradistinction with Education and the ideals and the functions of the University.

* * *

In the course of a paper read before the Geological, Mining and Metallurgical Society of India, Mr. D. N. Wadia observed that a very complete tertiary sequence from the Eocene to Pleistocene occurs in the Potwar geosynclinal basin of north-west Punjab, lying between the Hazara Himalaya and Salt Range mountains, consisting of marine, lagoon and fresh-water deposits, 25,000 feet thick. This basin structure persists south-eastwards and expands into the much wider Indo-Gangetic synclinorium lying between the Himalaya and Deccan. The latter is filled with the same system of deposits as the Potwar, as seen in the 30-40 miles wide strip of Tertiaries exposed along the Himalayan foot. Much the largest part of this trough, however, is deeply buried underneath sub-Recent Gangetic alluvium, due to its persistent subsidence during Pleistocene times while Potwar was being elevated to a plateau. It was this differential earth-movement which separated the Indus drainage from the Ganges and reversed the direction of flow of the latter from north-west to south-east. Palæontological evidence shows that these changes were subsequent to the advent of Man.

* * *

The eighth annual session of the Indian Philosophical Congress was opened by H. H. The Maharaja of Mysore, who is known alike for piety, public zeal and profound learning. Mysore is almost the birth-place of the three great systems of Hindu philosophy and its archives are filled with some of the rarest manuscripts providing abundant facilities for research. His Highness' address after reviewing the modern developments in the physical and the biological sciences, points to the possibility of philosophy synthesising them into new concepts of human values thus marking a new era of progress in religion and our fundamental ideas of Godhead. The greatly troubled world perhaps may draw some solace from the renaissance which a fusion of philosophy and science might usher into our life enriching the mind with new forces for its exaltation.

* * *

The Presidential Address of Sir S. Radhakrishnan was taken up with an elaborate exposition of Sri Shankara's doctrine of reality. The admirably analytical method of expounding this controversial theme which, while it satisfies those who have had the benefit of training in methods of comparative study, may not appeal to the orthodox exponents of the Advaita system. We must restrain our temptation to enter into the discussion of a subject which can be easily converted into polemics but the theories of science perhaps will give the most convincing reply. Referring to the troubles of modern times, Sir Radhakrishnan holds that the present distractions and the tragedy of the age are due to a sense of narrow specialization and excessive intellectuality; for progress has not brought contentment but has produced a void in life. "If they wanted to develop a true spirit, a new era in philosophy, in literature, in art and in morality, they should have an adequate realization of the powers of man. A play of life, satisfaction of mind, a feeling of peace,—it was these they wanted and these would have to be adequately developed to get life eternal."

* * *

Dr. Himadri Kumar Mookerjee of Calcutta writes to us that in the course of his investigation on the Indian Urodele *Tylototriton verrucosus*, he has discovered the remains of two genera of molluscs, *Pisidium* and *Indoplanorbis*. According to him, this is the first instance of molluscs being recorded as forming the food of Urodela whose staple food is generally worms and small crustacea. Land and fresh water molluscs have been known to be taken as food by Anura, some of which like *Rana tigrina*, are even cannibalistic in their feeding habits and slightest movement on the part of smaller animals is enough to excite the attention of Anura and Urodela which proceed to grab them. A piece of charcoal tied to a

string and dangled before the toad *Bufo melanostictus*, is greedily snatched at, but thrown out the moment the mistake is discovered. It is well known that movement on the part of animals provokes the curiosity of their enemies with fatal consequences.

* * *

Under the auspices of the Asiatic Society of Bengal a symposium on the Early History of Northern Bengal was held on Monday, the 2nd January 1933. The following papers were read and discussed :—

"Note on the Early History of Northern Bengal." By H. E. Stapleton.

"Note on a Mauryan Inscription from Mahasthan." By D. R. Bhandarkar.

"Note on Three Kushan Coins from North Bengal." By N. G. Majumdar.

* * *

The Progress of Agricultural Co-operation in Mysore was the subject of a recent address before the Mysore University by Mr. S. Venkatakrishnayya. After drawing attention to the heavy indebtedness of the peasantry, the lecturer cited evidence to show that in co-operation lies the hope of salvation to rural India. The public have not, however, awakened to the reality of the situation and the progress of co-operation is very slow: thus, although Mysore stands fourth in the country with regard to the organization of co-operative institutions, yet hardly 6 per cent of the agricultural population of the State have taken any interest in the movement. The lecturer the cited instances to show how the Irish Free State New Zealand and other progressive countries hav organized their agriculture and trade on co-opera tive basis and indicated how similar methods ca be introduced into Mysore. He laid particula emphasis on the need for (*a*) further legislatio against usury, (*b*) creation of land-mortgage bank with facilities for short-term loans, (*c*) co operative estate management and sale of produce and (*d*) organization of rural education, villag improvement and cottage industries.

* * *

In the course of an extension lecture delivere at the Lucknow University on 30th Novembe 1932, Mr. C. Maya Das, dealing with "Unemploy ment and Universities", laid emphasis on the nee for educated men and women applying their hand and brains to agriculture and related industrie He adduced evidence to show that there is ampl scope for expansion in cattle-breeding and dairy ing, poultry keeping, sericulture, fishery, la cultivation, bee-keeping and orcharding. Ther is also ready money in rice-hulling, oil-crushing pickling and preserving, while considerable saving can be effected by silaging surplus fodder an converting domestic and farm wastes into manure The lecturer concluded with exhorting his hearer to organize their efforts, to initiate co-operativ ventures, to always aim at superior quality an to strive for rural uplift including hygiene education and cottage industries.

Reviews.

INDIAN INDIGENOUS DRUGS. By Col. R. N. Chopra. First edition, pages xxii+655. (Calcutta: The Art Press, 1932.) Price Rs. 15.

Col. Chopra's latest book "The Indian Indigenous Drugs" is one of the most readable and useful publications which the reviewer has come across. The book owes its inception to an invitation by the Patna University to the author to give lectures as Sukhraj Ray Reader in Natural Science in 1929-30 on the medical and economic aspects of Indian medicinal plants. Later, as Chairman of the Drugs Enquiry Committee appointed by the Government of India in 1930–31, he came in intimate contact with the professions of medicine and pharmacy during his all-India tour and gathered together a large mass of useful information on the subject. Since the creation of the Calcutta School of Tropical Medicine in 1921, Col. Chopra has been in charge of the teaching and research work in Pharmacology, and has been engaged in the investigation of indigenous drugs. During these investigations he had the collaboration of the Department of Chemistry at the School in the two-fold preliminary work involved, namely, (1) the working out of the chemical composition of the drugs, an (2) isolation of their active principles. A physician to the Carmichael Hospital fo Tropical Diseases, attached to the Schoo he has had ample facilities to carry ou clinical trials with these drugs or thei active principles. The book is divided int four parts. The first part deals with th necessity of research in the vast field of in digenous drugs. The term 'indigenous drug' is used in a very broad sense and has bee taken to include not merely those drug which were originally the natives of Indi but also the exotics which had becom domiciled. The author gives a historica survey of the different attempts at researc on indigenous drugs during the last 100 yea or so and points out the reasons for the failure to get any definite results. He the discusses the three main lines along whic work was undertaken by the combined effor of the Departments of Chemistry and Pha macology of the Calcutta School of Tropic Medicine, aided by clinical trials at th Carmichael Hospital for Tropical Disease The aim of this work was both scientif and economic and may be summarised a follows :—

(1) To make India self-supporting by enabling her to utilize the drugs produced in the country and by manufacturing them in a form suitable for administration.

(2) To discover remedies from the claims of Ayurvedic, Tibbi and other indigenous sources suitable to be employed by the exponents of Western medicine.

(3) To discover the means of effecting economy so that these remedies might fall within the means of the great masses in India whose economic condition is very low. The desirability of using crude drugs, which are cheap, in place of the refined and finished preparations, is also discussed in this connection. The author makes out a special case for the cultivation of important medicinal plants in this country in view of the fact that India possesses a most wonderful variability so far as temperature and general climatic conditions are concerned. He very pertinently quotes Prof. Greenish of the London School of Pharmacy: "India, owing to the remarkable variations she possesses of climate, altitude and soil, is in a position to produce successfully every variety of medicinal herb required by Europe." It is, therefore, earnestly hoped that the subject will attract the attention of the Imperial Council of Agricultural Research and the Departments of Agriculture and Industries of the different Provincial Governments so that they may assist in prosecuting fundamental research on the subject which may stimulate the agriculturists to grow medicinal plants and the pharmaceutical chemist to manufacture drugs from them. The economic importance of this policy can only be fully appreciated by studying the position of the drug trade in India. The value of imports is estimated at about two crores of rupees per annum and that of exports at about forty lakhs. This adverse trade balance can be explained by the fact that drugs in crude form are exported from India to foreign countries at a nominal price, where they are utilized in various medical and allied industries and a portion of them is returned to India in the form of expensive preparations. A unique opportunity thus exists for the pharmaceutical chemist in this country, which if fully taken advantage of, will go a long way in removing unemployment among the educated classes. It will also bring into existence other allied chemical industries.

The second part of the book deals with pharmacopœial and allied drugs growing in India. The author has tried, in this section, to bring forward to the readers the enormous potential drug resources of India and the various ways and means by which these resources may be harnessed to the economic benefit of the country. A large number of these drugs grow wild and in great abundance in many parts of India but for want of definite knowledge about their constituents and active principles, these cannot be taken into use by the medical profession. The author has analysed a large number of these drugs himself and has shown that in many cases the Indian varieties are richer in their alkaloidal contents than those imported and can be safely used as a substitute for the more expensive foreign remedies. The readers will get very useful information and valuable suggestions regarding drug growing and drug manufacturing, not easily available elsewhere. The third part deals with the drugs used in the indigenous medicine. In this part a section is devoted to drugs of mineral and animal origin, and deals with makaradhwaja, musk, silajit and snake venoms. The chief object in both these parts of the book is to give a brief botanical description of the plants from which the drug is derived. This is followed by a short account of the chemical composition, the pharmacological action and the therapeutic uses of the drug. This is based mainly on the work done by Col. Chopra and his colleagues in the Departments of Pharmacology and Chemistry but a résume of practically all recent investigations on these drugs is also given. References for the convenience of the reader for getting further information from original sources are also inserted under each drug.

Part IV of the book deals with Indian *Materia Medica*. It is divided into three sections. Section 1 is a glossary of over 2,000 Indian medicinal plants. It gives the vernacular names, uses, chemical composition and references to any work published regarding them. This seems to be the most complete list of Indian medicinal plants published so far and has clearly cost a great deal of labour to the author. Sections 2 and 3 of this part deal with the inorganic and animal products used in the indigenous medicine.

Besides a comprehensive table of contents and a general index, the book contains an index of vernacular names of indigenous drugs, which is invaluable for purposes of reference.

From what has been said it is clear that this is a very useful book. It has both a scientific and economic interest. It should prove equally useful to the economic botanist and the organic chemist wishing to undertake work on important plant products and the medical man. Its economic interest lies in its usefulness as a guide to the agriculturist in showing him what types of medicinal plants should be grown and to the pharmaceutical chemist in indicating to him the possibility of manufacture of drugs derived from them. The book is well printed and is remarkably free from typographical errors. It is moderately priced.

B. K. S.

* * *

The Vitamins. By Sherman and Smith. ("An American Chemical Society Monograph" issued by the Chemical Catalogue Company, Inc.")

Our knowledge of the vitamins is increasing in such a bewildering manner, that a review of the subject like that which is presented in Sherman and Smith's monograph is eminently welcome. The book gives a well-balanced survey of the different facets of this rapidly developing section of biochemistry. The bibliography, which covers nearly one-third of the entire book, will be very useful to research workers and indicates the colossal amount of labour, that is being devoted to the elucidation of the chemical nature and the physiological function of these dietary factors.

Beginning with an exposition of the origin and development of the vitamin theory, the chapters deal severally and successively with vitamins B_1, B_2, C, A, D and E. The almost romantic stories of the discovery of the precursors of vitamins A and D are related in a lucid manner. The chapters on the B-vitamins give an up-to-date and detailed summary of the present position of the subject. Reference is also made to the recognition of the newer factors, necessary for the nutrition of the rat and the pigeon.

Monographs on vitamins, however, tend to be a little out-of-date almost as soon as they are published. Thus since the publication of this volume, our knowledge of vitamin D has progressed considerably. Vitamin C has been identified apparently beyond doubt as hexuronic acid and in the reviewer's laboratory the production of a vitamin *in vitro* from a known substance has been attempted apparently with success. Nevertheless, monographs of the nature of Sherman and Smith's volume are very des able, because they serve to coordinate t scattered data, which are accumulati apace. It is believed the book will be fou useful by all those, who consult it.

B. C. G.

* * *

The Mechanics of Deformable Bodi being Vol. II of "Introduction to Theoretic Physics" by Prof. Max Planck. Translat into English by Prof. Henry L. Bros (Macmillan & Co., Ltd., London, 1932.) Pri 10*s*. 6*d*. net.

In these days of rapid advancement Theoretical Physics it has become increa ingly necessary that the serious student Physics should have in his hands a wo which presents the fundamentals of t subject in a consecutive manner and trea it with necessary mathematical rigour. O can unhesitatingly say that among su works Prof. Max Planck's "Introducti to Theoretical Physics" occupies the fro rank. "The Mechanics of Deformab Bodies" forms the second volume of th work. The treatment is characterized by t clarity and conciseness which one expec from the eminent Mathematical Physici In introducing the subject the author, wh drawing attention to the necessity of maki simplifying assumptions in dealing wi particular groups of problems, makes t pregnant remark that 'Nature does not all herself to be exhaustively expressed human thought', the truth of which rece advances in Theoretical and Experiment Physics have made the modern stude realize more than ever.

The work is presented in three parts. Part I the general laws of motion of continuously extended body are dealt wi under the two heads, laws of kinematics a dynamical laws, forming the ground-wo for the superstructure built in Parts II a III. In Part II infinitely small deformatio receive treatment under the headings: Rig Bodies, States of Equilibrium of Rig Bodies, Vibrations of Rigid Bodies and V brations in Liquids and Gases. Part III co prises General Remarks, Irrotational Motio Vortex Motion and Friction. As one rea through the book one finds that the subje develops in a natural way with the fund mental problems coming under each hea treated with a clearness and thoroughne hardly to be excelled. While everything uniformly well done, no portion of th work calls for particular remark; we ar

however, tempted to draw particular attention to the Physical and Physiological aspects of musical intervals, musical scales and the ear as a Fourier analyser, models of clear and concise exposition. While speaking of the ear, the author says "An idea of this power of the organ of hearing, which borders on the miraculous, may be gathered if we reflect that the trained ear of a conductor is able to distinguish in the mass of sound produced by a combined choir and orchestra not only the tones and qualities of the individual instruments, but also the individual letters of the words that are sung. In this respect the ear is infinitely superior to the idea (*sic.* eye). For a colour, white, green or blue, is always experienced as something uniform and we are unable to specify directly whether and how this colour is composed physically of other colours."

The translation is well done. We heartily commend the volume to every earnest student of Physics.

B. V.

* * *

Fertilizers and Food Production. By Sir Frederick Keeble. Pp. ix+196. (Oxford: The University Press, 1932.) Price 5*s.* net.

A charming volume dealing with the possibilities of intensifying crop-production by judicious application of fertilizers.

After surveying the causes which led to the present depressed condition of agriculture in Great Britain, the author proceeds to discuss the means of increasing home-grown food for the future. Experiments carried out in different parts of the country and particularly those at the Jealott's Hill Farm have shown in a convincing way that increased yields varying from 15–30 per cent. can be obtained by judicious and timely application of fertilizers. Great Britain is essentially a grassland country and the soil and climatic conditions are such that in most parts of the island far bigger returns can be obtained by intensive grassland farming than by arable farming. Experiments on grazing in intensively managed holdings have shown that a larger number of cattle and sheep can be maintained per unit area together with a considerable saving in the cost of concentrates than in the past. Furthermore, grass can be preserved for winter use by silaging or by special processes of quick drying which yield products that are superior to the present type of stored hay. The efficacy of strip grazing, rotation of crops applicable to grassland and the economics of fertilizing and the returns therefrom are discussed and evidence adduced to show that the farmer always stands to gain by judicious use of fertilizers. The book concludes with schemes for scientific use of fertilizers for different crops and an appendix of recent data supporting the various statements made in the text.

The book is unfortunately one-sided and deals only with the application of mineral fertilizers in British farming. No mention is made of possible extensions of such observations to agriculture in other parts of the world: nor is full justice meted out to organic manures, which in spite of their bulkiness and somewhat tardy availability are more consistent in their action than any combination of artificials that man has so far devised.

The book is written in delightful style and well illustrated with tables and charts. The printing is in excellent type and on good paper and Messrs. Oxford University Press deserve to be congratulated on their performance.

V. S.

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CONTENTS.

N.B.—Contributors and Advertisers—please see notice on the inside cover of back page.

Services and Salary-Cuts.*

THE Budget forecast for 1933-34 being expected to yield a surplus, is made the occasion by the various commercial and industrial organizations for pressing on the Central and Local Governments their claims for remission of emergency taxes imposed on trade and produce of the land. At the recent conference of Associated Chambers of Commerce in Calcutta, the following resolution was passed: "This Association draws the attention of the Government of India to the heavy burden of taxation now borne by commerce and industry in this country and records its opinion that any improvement in the financial situation should be reflected in the first place by the alleviation of this burden." Judging from speeches in support of this motion, we infer that both Sir E. C. Benthall and Mr. G. L. Winterbotham are definitely of opinion that restoration of salary-cuts should not be permitted to take precedence over relief to businessmen and industrialists. On the discussions of the Madras Finance Committee the press reports that while a remission of land taxes was urged, the members recognized "the need on the part of the Government to honour their pledge to their servants and sought to impress on the Government the possibility of retaining at least a part of the cut, having regard to the fact that the economic crisis could not be said to have passed away sufficiently to justify any restoration of the entire salary-cut." The recommendations of the General Retrenchment Advisory Committee appointed by the Government of India are not known, but from lobby talks reported in the press it appears that the restoration of salary-cuts and reduced remuneration to the members of All-India and Provincial services were discussed and the Finance Member is stated to have pointed out that "it would not be fair to let the committee shoulder the burden of responsibility for the settlement of this important issue and that it would be much better if the problem were left to the Government to solve on its own responsibility." In the meantime the Bombay Reorganization Committee have presented their report recommending new groupings of services and reduced differential rates of salaries.

*The Madras Retrenchment Committee Report has appeared since this was written. We propose to consider it in a subsequent issue.

We can only hope that the brighter financial position anticipated during the next official year will not be fugitive, because even a political Isaiah cannot prophesy the destiny of world trade, industry and finance. They are so closely linked with the wider and more vital issue of war-debts that unless these are abolished financial prosperity must remain a chimera. It is certainly premature for the Government to accept the recommendations of the Retrenchment Committees without a definite knowledge of the fresh financial burdens which the political reforms may impose on the country. The financial disruption of the year 1932-33 was the crisis of events which, dating from 1919, finally unhinged the whole economic system of the countries involved in the Great War. Is there any justification, however, for supposing that financial depression, economic dislocation and industrial disorganization will be the future normal complexion of political and economic life? We prefer to think that the spectre will be eventually banished by trade prosperity, though it is evident that first some satisfactory solution of the war-debts problem must be reached, of which there seems to be no immediate prospect.

The Bombay Retrenchment Committee opens its report with the pragmatical sentence, "There is probably no direction in which there is greater room for permanent retrenchment than that of the pay of the services." Inspiration for such a baleful dictum may be the statement reported to have been made by Sir George Schuster when introducing the budget in March last, namely, "A democratic Government is certainly going to cost more and unless you can reduce the standard of pay throughout the services, I do really foresee very great difficulties before this country." Does the apprehension of the Finance Member suggest that he foresaw permanent shrinkage in the revenues for a sufficiently long time to justify his remarks about a general reduction of salaries? Now the financial position in some provinces and in the Central Government has altered for the better. If this improvement is a temporary accident, the Associated Chambers of Commerce, the Landholders' Association and the Services cannot press for any alleviation, until the Government are in a position to gauge their financial position with reference to the reforms. In fact, it is difficult to see how in the present state of uncertainty about future commitments, commerce and industry alone can be favoured without a corresponding reli being given to the members of the publ service. If, however, it can be proved tha the general revenues will be augmented b reducing taxes on land, industry ar commerce, and the Government were so t limit their relief, we are of opinion that th services will accept such a decision in cheerful and patriotic spirit, hoping for permanent and steady improvement of th situation in which their sacrifice ar hardship will not be forgotten.

Reduction in the salaries of the differen grades of appointments as a temporar measure may be comparatively harmles but as a permanent feature of the service it raises once again the old issue specific in the report of the Islington Commissio "The Government should pay so much an so much only to their employees as necessary to obtain recruits of the righ stamp and maintain them in such a degr of comfort and dignity as will shield the from temptation and keep them efficien for the term of their services." The L Commission has stated emphatically tha the basic pay of the services should not b reduced.

It is true that the cost of administratio must not exceed what the country ca bear, but it is dangerous to reduce the pa of officers to scales which may not shie them from temptation. It would be a act of high statesmanship to achieve pe manent reduction in the cost of administr tion without affecting the tone and spi of its members built up so laborious through generations, and without injuri the true interests of a vast multitude uneducated and helpless people whose be protection is the service tradition of inte rity and efficiency. The stability an success of democracy depend less retrenchment of cost than on outlook an temper. It is doubtful whether reduc scales of pay in public administration w continue to attract the gifted members the universities, while commerce, law an medicine offer more glittering prizes industrious and talented young men.

If the returning prosperity finds t Government still compelled to reduce rem neration in the services, there are two wa of treating such a reduction. The cost educating the children, house-rent an medical bills are important items in t domestic budget of every Governme official and the difference between the o

and reduced rates,—if the latter prove inevitable,—might be made good to the services by providing reasonable relief in these directions. The financial sacrifice which an officer is called upon to make might be compensated by free education of his children, free medical service for the family and a house allowance calculated at five per cent on the salary, subject to a maximum of rupees one hundred. In this case a uniform salary-cut of ten per cent will not be equitable, but a graded scheme of five per cent on salaries upto five hundred, ten per cent upto a thousand and fifteen per cent on higher salaries will have to be considered especially in view of the fact that under a permanent cut, the existing standard of life becomes upset by seriously diminishing the margin of comforts and provision for the family.

This scheme may, however, prove no cheaper than the continuance of present rates of pay and we, therefore, suggest another alternative. In times of budget surplus the savings accruing from the reduction of salaries may be consolidated in Service Trust Funds which will be available for utilization by the Government. At the time of retirement the officer would receive a bonus of fifty per cent of the amount which has accumulated to his credit through the cut in the salary. He may not be permitted to obtain any loan from the Funds nor be entitled to claim interest. This bonus will be purely in the nature of provision for the family which occupies the anxious thoughts of all Government servants at all times. In case of death the family would receive the whole amount which has accrued to the credit of the officer though no interest need be paid. While a prosperity budget is certain to provide opportunities for every community and institution to benefit, it is not fair to single out one class of devoted servants for unconditional sacrifice. The second scheme that we have suggested imposes no additional burdens on commercial and agricultural classes, nor will they unhinge the budget of the Government. Will it not be found to allay the apprehension that "the democratic government in India is certainly going to cost more"? It will certainly preserve unimpaired the high reputation of the public services which their members have built up through generations of hard work and devotion to duty. It is almost a truism to say that the greatest and safest asset of the people under any form of government is an efficient, loyal and pure administration and the reformed government in India will be able to protect and advance the interests of her people only by maintaining the best traditions of her public service.

Verification of the Phenomenon of Partial Absorption of Soft X-Rays.

By Dr. M. N. Saha, D.SC., F.R.S., *Allahabad.*

A RECENT communique by F. G. Chalklin and L. P. Chalklin to the Academy of Sciences, Paris (*Compt. Rend.*, 1932, **194**, 374)* deals with the verification by a new method of the phenomena of Partial Absorption of X-ray quanta by Dr. B. B. Ray of the University College of Science, Calcutta, which was first announced in *Nature*, **125**, 1930, and published in greater detail in the *Zs. f. Physik*, **66**, 231. Dr. B. B. Ray observed that when monochromatic X-rays (say Ni $K\alpha$, or $K\alpha$ and $K\beta$ of Fe) are passed through thin layers of light elements like Carbon, Oxygen and Nitrogen and spectro-photographed, there appear on the plate, besides the original line, lines at lower frequencies corresponding to $\nu—\nu'$ where ν is the frequency of the original irradiating quanta, and ν' is the characteristic K absorption of the element traversed. At first, Dr. Ray was inclined to the view that the modified line was an X-ray analogue of Raman Effect, but in a subsequent issue of *Nature*, **127**, 305, 1932, it was pointed out simultaneously by Dr. Ray and by Messrs. Bhargava and Mukherjee (Allahabad) that the phenomenon was due to absorption of part of the quantum by the electrons in the K shell of the medium traversed. What happens may be thus described:—As a quantum passes through the K shell of C (or any other light element), it gives to the K electron just sufficient energy so that it may be removed to infinity; so it is deprived of this amount from its stock of energy and reappears as a modified quantum with the energy content h $(\nu—\nu')$. Bhargava and Mukherjee further pointed out that this phenomenon might be treated along with the class of phenomena investigated by Robinson and De Broglie in which X-ray

* See Research Notes, p. 247.

quanta are allowed to traverse matter, and liberate electrons, and the energy of the liberated electrons is found to be h (ν—ν'). This is a case in which the whole energy of quantum is delivered to the electron, while in the case discussed here only a part just sufficient to liberate the electron is imparted. These are two extreme cases, and one is justified in assuming that the process is continuous, *i.e.*, a passing quantum can give to an electron inside an atom an amount of energy just equal to or greater than the amount required to liberate it, the excess appearing as the K. E. of the electron. The maximum K. E. should be h (ν—ν') as observed by Robinson and others. But these authors did not examine the state of the quantum after it had traversed matter which was done by B. B. Ray. If the above view be correct the modified quanta should appear as a band with a sharp limit at ν—ν' as observed by Ray, and extending to the long wave-length side indefinitely up to $\nu=0$. This band was actually observed by Bhargava and Mukherjee (*Nature, loc. cit.*). In spite of the fact that Ray's discovery is theoretically quite possible, and has been verified by other Indian workers, the reality of the effect was doubted, because many European and American workers were unable to reproduce it in the laboratory (*vide* para 2 of Chalklin's note). The following communication is important, because it is the first verification in a European laboratory, of not only the phenomena discovered by Ray, but also of the important feature of the case pointed out by Bhargava and Mukherjee. It is all the more important because in this experiment no crystal, which may give rise to false lines, but a grating was used. The failure of the other workers is to be attributed either to their use of large thicknesses of absorbing matter or to some other defect in their technique. It may also be pointed out that the phenomenon is extremely rare. Calculation with the data of one experiment has shown that only one quanta in 10^9 is modified by part-absorption on its passage through matter.

The Magnetic Moment of the Nucleus.

By Prof. B. Venkatesachar, M.A., F.Inst.P., *Central College, Bangalore.*

In an attempt to explain the hyperfine structure exhibited by spectral lines Pauli introduced the hypothesis that the nucleus has a spin and consequently a magnetic moment. He also pointed out that investigations of the Zeeman effect of hyperfine structure would throw light on the magnetic properties of the nucleus. This hypothesis received full confirmation from the classical work of Back and Goudsmit on the hyperfine structure of Bismuth lines. The observed hyperfine structures conformed to the interval and intensity rules and the Zeeman effect was determined to be $4\frac{1}{2}\ h/2\pi$. Since this pioneer work the hyperfine structure of many elements has been investigated, and the spins of the corresponding nuclei have been deduced. In some cases the spin has also been calculated from the alternation of intensity in band spectra and the values found are small integral multiples of $\frac{1}{2}\ h/2\pi$. Now, the spin and the magnetic moment of the electron are related so that e/mc times the spin is equal to the magnetic moment. If a similar relation be supposed to hold in the case of the nucleus also, its magnetic moment should be expected to be of the order of 1/1835 of a Bohr magneton, since the mass of a proton is 1835 times that of the electron. It is found that the electrons in the nucleus must be supposed to have lost their spin in order to be able to understand the smallness of the g(I) factors of nuclei. A knowledge of the g(I) factor can be obtained in the following way:—

The fact that the interval rule is applicable to hyperfine structure separations is contained in the equation

$$W_{ij} = A\ (j)\ ij\cos\ (ij) \ldots\ldots\ldots\ldots (1)$$

Here A(j) is the interval factor; a theoretical expression for it has been obtained by Fermi, Breit and Cassimir, as also by Goudsmit, in the case of a single valence electron, not of s-type. The expression is

$$A(j) = \frac{l(l+1)}{j(j+1)}\, a_{nl} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where a_{nl} is the interaction constant of the valence electron. Its value can be calculated rigorously only by a quantum-mechanical treatment of the state under consideration. But for non-s-types of penetrating orbits it is approximately given in cm.$^{-1}$ by

$$a_{nl} = \frac{R\alpha^2 Z_i Z_o^2}{n_e^3 l(l+1)(l+\frac{1}{2})}\, g(\mathrm{I}) \ldots\ldots\ldots (3)$$

Here Z_i and Z_o are the effective nuclear charges in the inner and outer parts of the orbit and n_e is the effective total quantum number. When there are more valence electrons than one the interval factor $A(j)$ can be expressed in terms of the interaction constants a_{nl} of the several electrons by making use of the method of energy sums as shown by Goudsmit (*Phys. Rev.*, **37**, 668, 1931). In this way one obtains for the 6s6d configuration the equations

$$\tfrac{1}{12}\, a_{6s} + 2\, a_{6d} = A(^3D_2) + A(^1D_2) \ldots (4)$$

$$-\tfrac{1}{4}\, a_{6s} + 2\, a_{6d} = A(^3D_1) \ldots\ldots\ldots\ldots (5)$$

while for the 6s6p state one gets

$$\tfrac{1}{4}\, a_{6s} + \tfrac{2}{5}\, a_{6p} = A(^3P_2) \ldots\ldots\ldots\ldots (6)$$

$$\tfrac{1}{4}\, a_{6s} + 2\, a_{6p} = A(^3P_1) + A(^1P_1).\ (7)$$

The 6s7s configuration yields the equation

$$\tfrac{1}{2}\, (a_{6s} + a_{7s}) = A(^3S_1) \ldots\ldots\ldots\ldots (8)$$

The propriety of applying these equations to any particular case can be tested by the consistency of the values of a_{6s} obtained from the various configurations. The $g(I)$ factors of two nuclei can be compared by means of (3) when the values of a_{nl} are known in each case for the same value of n and l. Such a comparison is particularly instructive in the case of the two mercury isotopes Hg_{199} and Hg_{201} since here the two nuclei differ only by two protons and two electrons (*i.e.*, by two neutrons if the electrons are supposed not to have a separate existence).

The values of $A(^3D_2)$, etc., can be obtained from the analysis of Schüler and Jones (*Zs. f. Phys.*, **77**, 809, 1932). We have

$A(^3D_2) + A(^1D_2) = \tfrac{2}{5}(0{\cdot}752 - 0{\cdot}470) = 0{\cdot}113.$

$A(^3D_1) = -\tfrac{2}{3}(0{\cdot}493) = -0{\cdot}329.$

Hence from (4) & (5), $a_{6s} = 1{\cdot}326$ cm.$^{-1}$

$A(^3P_2) = (\tfrac{2}{5})\,(0{\cdot}758) = 0{\cdot}303;$

$A(^3P_1) + A(^1P_1) = \tfrac{2}{5}(0{\cdot}727 - 0{\cdot}181) = 0{\cdot}364.$

Hence from (6) and (7) $a_{6s} = 1{\cdot}150.$

The value of a_{6s} for Tl II, obtained from the same configurations are (see McLennan, McLay and Crawford, *Proc. Roy. Soc.*, **A 133**, pp. 657 and 663, 1931) 5·85 and 4·88 respectively. The ratio of the $g(I)$ factors of Hg and Tl can now be calculated from (3). We thus obtain

$$\frac{g(I)_{Hg}}{g(I)_{Tl}} = \frac{(a_{6s})_{Hg}\,(n_e)^3_{Hg}\,(Z_i)_{Tl}\,(Z_o)^2_{Tl}}{(a_{6s})_{Tl}\,(n_e)^3_{Tl}\,(Z_i)_{Hg}\,(Z_o)^2_{Hg}}$$

$$= 0{\cdot}73 \text{ and } 0{\cdot}77 \text{ respectively.}$$

Thus the $g(I)$ factors of Hg_{199} and Tl are of the same order. We can now calculate a_{6s} from (8) as follows: a_{7s} of Tl I $= 0{\cdot}417$ cm.$^{-1}$ n_e for $7s\,^2S_{\frac{1}{2}}$ of Tl I is 2·19; n_e for $6s7s\,^3S_1$ of Hg I is 2·24, while for $6s7s\,^1S_0$ of Hg I it is 2·32; hence n_e for Hg I 7s is 2·28. Z_i is 80 for Hg and 81 for Tl. Therefore from (3) a_{7s} of Hg I is 0·274. But since $A(^3S_1)$ of Hg_{199} is $\tfrac{2}{3}$ (1·070) = 0·713, (8) yields $a_{6s} =$ 1·152. This value lies between the values 1·326 and 1·150 previously obtained; similarly, the corresponding value in Tl II, *viz.*, 5·40 lies between those obtained from the 6s6d and 6s6p configurations, *viz.*, 5·85 and 4·88. The consistency of these results shows that we are justified in applying the theory in the above manner.

A similar calculation in the case of Hg_{201} gives a_{6s} the value –0·495 from the 6s6d configuration and –0·445 from the 6s6p configuration. Thus the $g(I)$ factor of Hg_{201} is 0·38 times (mean of 0·387 and 0·373 obtained from the two pairs of values) that of Hg_{199}. The problem is to draw conclusions about the structure of the nuclei from the knowledge of the ratio of their $g(I)$ factors.

Following the discovery of the neutron, Heisenberg (*Zs. f. Phys.* **77**, 1, 1932) has shown that observed facts can be best explained by giving up the idea of the separate existence of electrons inside the nucleus, considering it to be made up of protons and neutrons alone. Remembering the great stability of α- particles we may assume that pairs of protons and neutrons are as far as possible combined into α- particles. When the atomic number is even there will be only α- particles and neutrons, while if Z is odd, there will be one extra proton. Since Hg_{199} and Hg_{201} differ only by two neutrons, the latter must be thought of as having orbital motion as well as spin, in order to understand the difference in their $g(I)$ factors. Making this assumption, it has been shown (B. Venkatesachar and T. S. Subbaraya, *Cur. Sci.*, **1**, 120, 1932) that the neutron configuration of Hg_{199} is $4d^2 5s$. The g factor of the corresponding $^2S_{\frac{1}{2}}$ term is 2. The neutron configuration of Hg_{201} is $4d^3 5s^2$ and corresponding to the spin 3/2, the term may be $^2D_{3/2}$, $^4P_{3/2}$, or $^4F_{3/2}$. The g factor of Hg_{201} is therefore 4/5 or 26/11 or 2/5. The ratio of the $g(I)$ factors of Hg_{201} and Hg_{199} deduced above may be understood if the state of Hg_{201} is assumed to correspond to $^2D_{3/2}$. The calculated value of the ratio of the g factors will then be 0·40 in good agreement with the value 0·38 found above.

Comparing Hg_{199} and Tl, the magnetic moment of Hg_{199} should be that of a neutron, while that of Tl is due to a proton. If now the neutron is thought of as a sphere of positive electricity imbedded in a sphere of negative electricity which is very much larger, the entire structure rotating with one angular velocity, and the moment of the whole being $\frac{1}{2}\, h/2\pi$, its magnetic moment will be of the same order as that of the proton, and the approximate equality of the g(I) factors of Hg_{199} and Tl become intelligible.

Next considering Tl and Pb, the term corresponding to the spin $\frac{1}{2}$ in the case of Pb may be $^4D_{\frac{1}{2}}$ or $^4P_{\frac{1}{2}}$ or $^2P_{\frac{1}{2}}$, so that the g factor may be 0 or 8/3 or 2/3. If the term is taken to be $^2P_{\frac{1}{2}}$, the ratio of the g factors of Tl and Pb comes out to be (magnetic moment of the proton) / (one-third of magnetic moment of the neutron), that is 4, if the magnetic moment of the neutron is assumed to be 0·75 times that of the proton on the basis of our previous comparison of Hg_{199} and Tl. The value deduced by McLennan is between 3·7 and 5 (*loc. cit.* p. 666), thus agreeing with the theoretical value.

To interpret the ratio between the g(I) factors of Tl and Bi deduced by McLennan (from 3·2 to 4·4; *loc. cit.*, p. 665) we have to consider the spin $4\frac{1}{2}$ of the Bi nucleus as due to a $^3G_5$ term with the spin of the proton oppositely directed. Then the magnetic moment of the Bi nucleus $= \frac{6}{5} \times 5 \times \frac{3}{4} - 1 = \frac{7}{2}$ so that its g factor $\frac{7}{2} \times \frac{2}{9} = \frac{7}{9}$. Hence the ratio of $g(\mathrm{I})_{Tl}$ to $g(\mathrm{I})_{Bi} = 18/7 = 2 \cdot 6$. In this case the numerical agreement is not so good as before, but considering the uncertainties in the value deduced by McLennan, as also in the ratio between the magnetic moments of the proton and the neutron, exact numerical coincidence cannot be expected. Considerations of a similar nature may be expected to lead to an understanding of the extremely small value of the g(I) factor in the case of elements like chlorine.

A Note on the Special Theory of Relativity.

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IT has been pointed out (*Current Science*, 1, 160, 1932) that if there are two particles A and B of rest masses m_1 and m_2 (with respect to each other) moving with a relative velocity v, the total mass of the system can be calculated in two different ways. If m_1 be assumed to be at rest then the total mass of the system is found to be $m_1 + \dfrac{m_2}{\sqrt{1-\frac{v^2}{c^2}}}$ where c is the velocity of light. On the other hand, if m_2 is supposed to be at rest the total mass of the system becomes $m_2 + \dfrac{m_1}{\sqrt{1-\frac{v^2}{c^2}}}$. Clearly, these two expressions for the total mass are different.

In the first case the total energy of the system apart from the interaction energy (which, if any, will be the same in both the cases) is

$$m_1c^2 + \frac{m_2c^2}{\sqrt{1-\frac{v^2}{c^2}}}\ ;\ i.e.,\ m_1c^2 + m_2c^2 + \tfrac{1}{2}\, m_2v^2$$

neglecting terms of higher order of small quantities. In the second case the total energy apart from the interaction energy would become $m_2c^2 + \dfrac{m_1c^2}{\sqrt{1-\frac{v^2}{c^2}}}$;

$$i.e.,\ m_2c^2 + m_1c^2 + \tfrac{1}{2}\, m_1v^2$$

neglecting terms of higher order of small quantities. These two expressions for energy are different.

We also see that according to the observer A the total linear momentum of the system is $\dfrac{m_2v}{\sqrt{1-\frac{v^2}{c^2}}}$ and according to the observer B it is $\dfrac{-m_1v}{\sqrt{1-\frac{v^2}{c^2}}}$. These two expressions are evidently numerically different.

If there are two or more observers we can show more generally that the total energy of a system of particles becomes different when measured by different observers; and the law of conservation is not true in this sense, and the total energy is not an absolute property of the system. However, it is quite possible that for each particular observer the total energy may remain constant throughout the motion, but it is no new principle. The above remarks apply

equally well to the case of total linear momentum.

We shall see presently that the principle of relativity creates another difficulty to which attention has not been drawn before, *viz.*, failure of the concept of the centre of mass as a definite point. It is necessary to call attention to this fact, as when dealing with a number of particles, the concept of the centre of mass has sometimes been used.

Let us take, as before, two particles A and B having the rest masses m_1 and m_2 and let them start moving with respect to each other with the velocity v.

Let B′ be the point which is at rest with respect to A but which momentarily coincides with B at the instant t measured by A. Let AB be equal to r as measured by A. Now, for the observer at A the problem is reduced to a statical case of finding out the centre of mass of two masses m_1 and $\dfrac{m_2}{\sqrt{1-\frac{v^2}{c^2}}}$ at A and B′ respectively. Let the centre of mass be G_1 as found by A. Then according to the measurement of A

$$AG_1 = \frac{m_2 r}{\sqrt{1-\frac{v^2}{c^2}}} \Bigg/ \left[m_1 + \frac{m_2}{\sqrt{1-\frac{v^2}{c^2}}} \right]$$

$$= \frac{m_2 r}{m_1+m_2} + \tfrac{1}{2}\frac{m_1 m_2 v^2 r}{(m_1+m_2)c^2} \text{ (neglecting small quantities of higher orders).}$$

$$B'G_1 = -\left\{ \frac{m_1 r}{m_1+m_2} - \frac{\frac{1}{2} m_1 m_2 v^2 r}{(m_1+m_2)c^2} \right\} \text{ (neglecting small quantities of higher orders).}$$

Similarly, take A′ to be the point which is at rest with respect to B but which momentarily coincides with A at the instant t' measured by B. In order that BA′ may be numerically equal to AB′ we have to take t and t' suitably related.

We have $AB' = a + vt$, *i.e.* when $t = 0$ as measured by A the distance between the particles was 'a' according to A. Further, $BA' = -(b + vt')$, *i.e.* when $t' = 0$ as measured by B the distance between the particles was $(-b)$ according to B so that in order that $(AB') = -(BA')$ (as measured by A and B respectively) we get $a + vt = b + vt'$ *i.e.*, $t' - t = \dfrac{a-b}{v}$. We see that a and b depend upon the initial conditions of the problem.

Now for the observer at B the problem is reduced to a statical case of finding the centre of mass of masses $\dfrac{m_1}{\sqrt{1-\frac{v^2}{c^2}}}$ and m_2 at A′ and B respectively. Let the centre of mass be G_2 as found by B. Then according to the measurements of B

$$BG_2 = \frac{-m_1 r}{\sqrt{1-\frac{v^2}{c^2}}} \Bigg/ \left[m_2 + \frac{m_1}{\sqrt{1-\frac{v^2}{c^2}}} \right]$$

$$= -\left\{ \frac{m_1 r}{m_1+m_2} + \tfrac{1}{2}\frac{m_1 m_2 v^2 r}{(m_1+m_2)c^2} \right\}$$

(neglecting small quantities of higher order);

also $A'G_2 = \dfrac{m_2 r}{m_1+m_2} - \tfrac{1}{2}\dfrac{m_1 m_2 v^2 r}{(m_1+m_2)c^2}$ (neglecting small quantities of higher order).

Expressions for AG_1 and $A'G_2$ are different.

We know that if two systems of reference A and B move with a relative velocity v then to an observer on A the unit of length of A along the line of relative motion appears to be in the ratio $\sqrt{1-\frac{v^2}{c^2}} : 1$ to that of B while to an observer on B the unit of length of B along the line of relative motion appears to be in the ratio $\sqrt{1-\frac{v^2}{c^2}} : 1$ to that of A. To the observer A the distance $A'G_2$ will appear to be

$$\frac{m_2 r}{m_1+m_2} \cdot \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - \tfrac{1}{2}\frac{m_1 m_2 v^2}{(m_1+m_2)c^2} \cdot \frac{r^2}{\sqrt{1-\frac{v^2}{c^2}}}$$

i.e., $\dfrac{m_2 r}{m_1+m_2}$ (neglecting small quantities of higher order).

Even for observer A, G_1 and G_2 are different points. The concept that the centre of mass is a definite point with respect to any configuration of particles fails.

Now m_1 and m_2 are the masses of two particles A and B when they are relatively at rest with respect to each other. Eddington calls them "proper masses" or "invariant masses" and assumes that they have absolute inertial properties and remain unaltered throughout the vicissitudes of their history (Eddington's *Mathematical Theory of Relativity*, p. 30). Let us examine Eddington's assumption a little more carefully. There are two possibilities:—

(*a*) The rest masses m_1 and m_2 of any two particles A and B with respect to each other have the same values in presence of other bodies whatever be their common relative velocity with respect to each of these bodies.

(*b*) The values of the rest masses of A and B with respect to each other may change in the presence of other bodies by amounts which depend on the magnitude of their common relative velocity with respect to each of the other bodies.

Let us now examine the first possibility. Let there be three particles A, B and C. According to the hypothesis the rest masses of A and B between themselves remain the same irrespective of the presence of the third body C. Similarly, the rest masses of the particles A and C between themselves remain the same in spite of the third body B. Now let three bodies A, B and C be relatively at rest with one another and their rest masses with respect to one another be m_1, m_2 and m_3. According to the hypothesis, the rest masses m_1 and m_2 between A and B have not altered due to C and also the rest masses m_1 and m_3 between A and C are not altered due to B. If there is any other particle D we find that the rest masses between A and D are m_1 and m_4 irrespective of the presence of other bodies. So it follows that m_1 is an absolute property of the particle A if the first possibility is true. Let us see if this is borne out by facts.

Let M_1, M_2, M_3, etc. be the masses of the particles A, B, C, etc. and v_1, v_2, v_3, etc. be their relative velocities as measured by an observer S and let M'_1, M'_2, M'_3, etc. be the masses of the same particles and v'_1, v'_2, v'_3, etc. be their velocities as measured by another observer S′. Let u be the velocity of S with respect to S′. Then

$$M_1 \sqrt{1-\frac{v_1^2}{c^2}} = M'_1 \sqrt{1-\frac{v_1'^2}{c^2}},$$

as each of them is equal to m_1 in virtue of the first possibility. We have similar relations for other particles. Therefore we have

$$\Sigma M_1 v_1 = \Sigma M'_1 v_1 \frac{\sqrt{1-\frac{v_1'^2}{c^2}}}{\sqrt{1-\frac{v_1^2}{c^2}}}.$$

Now
$$\frac{v_1}{\sqrt{1-\frac{v_1^2}{c^2}}} = \frac{1}{\sqrt{1-\frac{u^2}{c^2}}} \cdot \frac{(v'_1-u)}{\sqrt{1-\frac{v_1'^2}{c^2}}}$$

(see p. 31, *Mathematical Theory of Relativ ty*, Eddington).

So we get

$$\Sigma M_1 v_1 = \frac{\Sigma M'_1 v'_1}{\sqrt{1-\frac{u^2}{c^2}}} - \frac{u\,\Sigma M'_1}{\sqrt{1-\frac{u^2}{c^2}}} \quad \text{...(A)}$$

Similarly we also get

$$\Sigma M'_1 v'_1 = \frac{1}{\sqrt{1-\frac{u^2}{c^2}}}\,\Sigma M_1 v_1 + \frac{u}{\sqrt{1-\frac{u^2}{c^2}}}\,\Sigma M_1 \quad \text{...(B)}$$

Eddington has assumed, it appears rather arbitrarily, that the equation (A) is satisfied and has then come to the conclusion that the rest masses m_1, m_2, etc. are absolute properties of the particles. There does not seem to be any justification for such an assumption.

Clearly $\Sigma M'_1 v'_1$ is not equal to $\Sigma M_1 v_1$. When there are two or more observers total linear momentum of a system of particles becomes different for different observers, and the law of conservation is not true in this sense, and the total linear momentum is not an absolute property of a system of particles or bodies.

From (A) and (B) it is evident that if for each particular observer the total mass is conserved, then for him total linear momentum will also be conserved.

There is one serious difficulty, when we talk of any conservation theorem in connection with a number of particles in the theory of Relativity, as we have to bring in forces existing between them. This involves the idea of the distance, and the quantity giving the total energy or linear momentum becomes ambiguous. Hence it appears that we cannot talk of any conservation theory existing between a number of particles in the theory of Relativity.

Under the second possibility the rest masses are clearly not the absolute properties of the particles. Moreover, if m_1 is the rest mass of A with respect to B, then m_1 would not generally be the rest mass of A with respect to another particle C. It would be some other quantity m'_1. Each observer has his own particular world and measures the masses of the particles, their total energy and linear momentum in his own particular way. Unless some absolute property of each particle independent of the observer is conserved, there cannot be any correlation between the above quantities measured by different observers. Without any such correlation between measurements made by different observers the theory of Relativity cannot make much progress in explaining natural phenomena. So we see that some such postulate as the rest mass of a particle remains invariant throughout the vicissitudes of its history has become necessary.

Letters to the Editor.

A Search for the Hall Effect in Colloidal Electrolytes.

THE rotation by the magnetic field of the equipotential lines in a metallic plate carrying an electric current has been established by Hall[1] and a number of subsequent investigators[2]. Theoretically the existence of the above effect in electrolytes and in liquid metals is a possibility, but, perhaps, on account of the practical difficulties its complete establishment is a difficult proposition. Attempts made by Roiti,[3] Floria,[4] Chiavassa[5] and others have yielded negative results. The only positive results have been obtained by Oxley[6] and Baggard[7]. Since the discovery of the colloidal electrolytes by McBain[8] and his co-workers a considerable amount of work has been done to establish the electrolytic conductivity of the colloidal solutions. On account of the size of one of the conducting micelles the case of these substances presents special attraction from the point of view of the Hall effect.

A preliminary but a very searching examination has been made of solutions of sodium stearate with alcohol and water as solvents. The original method of Hall of connecting two transverse equipotential points to a galvanometer was tried. A rectangular cell of glass ($8 \times 3 \times 0 \cdot 15$ cm.) was prepared and placed in a magnetic field varying from 6,000 to 13,000 gauss. The electrodes were of silver and the distance between the primary electrodes was about 1 cm. The primary current was 3 microamperes as a greater current makes the galvanometer unsteady on account of gas bubbles produced. The upper Hall electrode was capable of very fine motion both in horizontal and vertical directions. It was adjusted to the same potential as the lower one and brought very near it so that the resistance between these may be small. In our experiments this was of the order of 600 ohms. The accuracy and sensitivity of the arrangement was tested by trying thin silver films which gave Hall effect of the right order. There was a large throw of the galvanometric needle due to induction but no permanent deflection, showing that under these conditions there is no Hall effect in sodium stearate solution. It is interesting to note that when one Hall electrode was in advance of the other a longitudinal galvanometric effect. reversible with the primary current but not with the magnetic field was observed. Experiments are in progress to investigate this effect and Hall effect in colloidal gels.

Our thanks are due to Prof. S. S. Bhatnagar for suggesting this problem.

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January 10, 1933.

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[8] McBain and Taylor, *Zeit. f. Physic. Chem.*, **76**, 179, 1911; McBain, Laing and Titley, *Trans. Chem. Soc.*, 1279, 1919.

N.B.—The complete bibliography upto 1923 after which no work has been done on Hall effect in electrolytes is given on page 101 of Campbell's "Galvanometric and Thermo-Magnetic Effects".

The Viscosity of Aqueous Solutions of Non-Electrolytes.

As we do not know the forces operating between the molecules of non-electrolytes in solution, it is almost impossible to derive the viscosity of non-electrolytic solutions on kinetic grounds. However, by the application of Porter's empirical rule[1] to the law governing the vapour pressure of solutions it is possible to derive an equation connecting viscosity and concentration.

Porter states (*loc. cit.*) that $1/\log \eta$ plotted against $\log p$ (where η represents the viscosity and p the vapour pressure of a liquid at the same temperature and pressure) gives a straight line. In other words $\log \eta = m \log p + k \ldots\ldots (1)$.

Assuming that Porter's rule holds for dilute solutions too—an assumption which seems to be justified by facts—we can connect viscosity with concentration by continuing equation (1) with $\frac{p_0 - p}{p_0} = \frac{n}{N}$ (2) where

[1] *Phil. Mag.*, April 1932, p. 460.

p_0 represents the vapour pressure of the pure solvent, p that of the solution, η represents the number of moles of the solute and N that of the solvent present in the solution.

The equation obtained is:—

$$\eta/\eta_0 = \left(1 - \frac{n}{N}\right)^m$$

where η represents the viscosity of the solution and η_0 that of the pure solvent.

For dilute solutions the above equation assumes the form, $\eta/\eta_0 = 1 - m\frac{n}{N}$ which can be written as $\eta/\eta_0 = 1 + AC$ where "A" represents a constant and "C" concentration of the solute.

There is very little data to test the correctness or otherwise of this formula, but the existing data (the viscosity of sugar solutions given in Bornstein Landolt's table) seem to support the above theoretical deduction.

Experiments are being conducted in this Laboratory to test the formula obtained.

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Separation and Purification of Enzymes through Substrate Adsorption.

SPECIFIC adsorptions of enzymes by their respective substrates which are well known, have been utilized for the separation and purification of enzyme preparations. Ambard[1] has shown that crude powdered starch adsorbs amylase from solutions to the extent of 95 to 100 per cent. This method has been employed by him for the estimation of amylase in saliva, blood and urine. Waldschmidt Leitz and Linderstrom-Lang[2] have found that trypsin-kinase can be specifically adsorbed on casein made to precipitate in the enzyme solution itself.

This principle has been adopted in the separation and purification of inulase from its associated invertase. Inulase extract (P_H 3.0) was treated with a suspension of purified inulin at 0°C. for 15 minutes and centrifuged. The precipitate of inulin, on analysis, was found to have adsorbed inulase to the extent of 50 per cent from the enzyme extract, while it was entirely free from invertase. Such a complete separation is not possible with calcium hydrogen phosphate which has been recommended for the purpose. An effective separation can also be achieved by allowing a 3 per cent solution of inulin to precipitate in the enzyme extract by freezing and separating the adsorption complex by centrifuging. Under similar conditions of experiment a suspension or solution of starch adsorbs neither inulase nor the associated invertase.

The method has also been successfully employed for the separation of the liquefying and saccharifying components of malt diastase. Malt extract cooled to 0°C. was stirred with finely powdered amylopectin (prepared by the method of Ling and Nanji, *J.C.S.*, **123**, 2666, 1923) and centrifuged. It was found that while the saccharifying power of the centrifugate was unimpaired, its liquefying power as determined by viscosity measurements, alcohol precipitation or iodine coloration, was markedly decreased, indicating a partial (25 per cent) removal of the liquefying component.

A detailed study of the formation of the above adsorption complexes in relation to reaction and concentration of the enzyme and substrate is being made. This method should prove useful in separating other enzyme mixtures.

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[1] *Bull. Soc. Chemie Biol.*, **3**, 51, 1921.

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The Colouring Matter of Khapli Wheat.

TRICIN, the colouring matter of "Khapli" wheat, was isolated by Anderson and Perkin[1], who showed that it was a dimethyl ether of a pentahydroxyflavone, tricetin (I), alkaline fusion of which led to phloroglucinol and an acid resembling gallic acid. They reported that (I), however, did not have the obvious structure of a 5: 7: 3′: 4′: 5′-pentahydroxyflavone (II), as a synthesis of the latter disclosed differences in the properties of (I) and (II).

(II) was first synthesised by Bargellini and Monti[2] and was described as decomposing

[1] Anderson and Perkin, *J. Chem. Soc.*, **139**, 2624, 1931.

[2] Bargellini and Monti, *Gazzetta*, **45**, 65, 1915; *Chemical Abstracts*, **9**, 2237, 1915.

above 270° and yielding an acetyl derivative, m.p. 216-218°. Badhwar, Kang and Venkataraman[1] prepared (II) by the Robinson reaction; they found that their product was similar to Bargellini and Monti's in its colour reactions, but they did not prepare the pentacetate.

Anderson[2] has repeated the synthesis of Badhwar *et al* and has demonstrated the identity of (I) and (II). In view of the discrepancy between the m.p.'s of the acetyl derivatives of Bargellini and Monti (216-218°) and Anderson (241-242°), we have undertaken a re-examination of (II) and its derivatives.

If tricetin has the structure (II) we have little doubt that tricin is its 3′ : 5′–dimethyl ether (III). The wide occurrence of the syringic nucleus among the anthocyanins and the probability of its recognition among natural flavone pigments has been indicated by Karrer and Widmer[3] and by Heap and Robinson[4]. A synthesis of (III) by the interaction of phloracetophenone with *o*-benzylsyringic anhydride is in progress in this laboratory.

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Feeble Anisotropies in Paramagnetic Crystals.

IT is known from the investigations of Rabi[5] and others that at ordinary temperatures single crystals of manganous salts are almost isotropic magnetically; the three principal susceptibilities differ from one another by less than one per cent. This result is what one would expect on the basis of the recent theories of Van Vleck and others[6] since the Mn^{++} ion is in an S state; and from the point of view of these theories a knowledge of the precise amount of deviation from perfect isotropy in these crystals is of some importance. For the purpose of measuring such feeble anisotropies as are involved here, we have adopted the following method:—

The crystal is suspended at the end of a calibrated quartz fibre so as to lie between the parallel pole-pieces of an electromagnet capable of giving a uniform field. When the field is put on, there will, in general, be two couples tending to rotate the crystal about the axis of suspension: (1) the couple due to the magnetic anisotropy of the crystal in the horizontal plane, and (2) the couple due to small deviations from homogeneity of the field, acting through the asymmetry of shape of the crystal. The latter couple is eliminated by surrounding the crystal with a paramagnetic solution (saturated with the substance) whose volume susceptibility has been adjusted to equal the mean volume susceptibility of the crystal.

The following two measurements suffice to determine the directions of the magnetic axes in the horizontal plane, as well as the difference between the susceptibilities along these axes. The crystal will rotate from the initial position when the field is put on; the first measurement is that of the angle of torsion of the fibre that is necessary to rotate the crystal back to its original orientation. If now the torsion head is rotated farther very slowly, at a certain stage the crystal suddenly turns round. This critical orientation of the crystal evidently corresponds to the maximum value of the restoring couple in the field, and therefore to an inclination of the two magnetic axes in the horizontal plane at 45° to the direction of the field. The angle of torsion for this orientation of the crystal is the second quantity measured.

By making similar measurements for other suitable axes of suspension of the crystal, the directions of the principal magnetic axes in the crystal and its anisotropy become known.

By way of illustration we may mention the results obtained by this method in the case of the monoclinic crystal $MnSO_4 . (NH_4)_2SO_4 . 6\,H_2O$. We find that at 30° C.

$$\chi_1 - \chi_2 = 11{\cdot}4$$
$$\chi_1 - \chi_3 = 6{\cdot}8$$
$$\tfrac{1}{3}(\chi_1 + \chi_2 + \chi_3) = 13830$$

where χ_1 and χ_2 denote the two principal gram molecular susceptibilities in the (010) plane, expressed in the usual unit, *viz.*, 10^{-6} of a c.g.s. e.m.u. χ_3 denotes the susceptibility along the '*b*' axis. Also the χ_1 axis is found

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[1] Badhwar, Kang and Venkataraman, *J. Chem. Soc.*, **141**, 1107, 1932.
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[4] Heap and Robinson, *J. Chem. Soc.*, **135**, 68, 1929.
[5] I. I. Rabi, *Phys. Rev.*, **29**, 174, 1927.
[6] See J. H. Van Vleck, *The Theory of Electric and Magnetic Susceptibilities*, Chap. XI (1932).

to lie in the acute angle β at 14·6° to the 'c' axis. It is seen that the largest difference between the χ's is less than one-tenth of one per cent.

The significance of this small anisotropy will be discussed in detail elsewhere. It may, however, be stated here that when allowance is made for the anisotropy of the diamagnetic part of the susceptibility, the residual anisotropy is of the same order of magnitude as may be expected from the simple magnetostatic influences of the doublets induced in the Mn^{++} ions.

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February 1, 1933.

The Industrial Outlook.

Development in Plastics.[1]

DURING the year 1932 the Plastics Group of the Society of Chemical Industry was formed of which group Mr. H. V. Potter, B.Sc., F.I.C., is the first chairman. The formation of this group within the Society had the possible effect of preventing the chemists and chemically minded technicians in the industry from grouping together to form a separate association of their own since neither of the existing bodies, the Trade Association or the Plastic Institute could be expected to cater for the purely chemical interests of this new industry.

Patent literature has continued during the year without abatement covering a few new types of plastics, modifications of existing types and application in particular fields for existing plastics. The older types such as celluloid, casein and natural resins have ceased to attract in the same way as the newer types such as the phenol-formaldehyde, urea-formaldehyde and more recently the cellulose ester and ether types. The nitrocellulose plastics, such as celluloid, have possibly ceased to hold the lead in tonnage production owing to the growth of the newer types. This class of plastics has steadily progressed and is still finding new applications along well-defined lines where inflammability is not a serious drawback. The finish, appearance and colour effects are still being improved and extended. Its use in safety glass has been hampered by the tendency to darken in colour.

The natural resin plastics, of which shellac is the largest ingredient, have unquestionably had a serious setback on account of the quiet state of the gramophone record industry. In spite of this, however, it is probable that it is the second largest class of plastics in the country. A large amount of work has been done on flexible records with the object of getting away from the use of shellac on account of the unstable price position of this material, and producing a record lighter in weight. So far the shellac record has not yet come up against a real rival in this respect on account of a number of technical and reproduction difficulties.

The natural resins, such as shellac, copal, kauri and collophony along with tung oil and other ingredients, namely, bitumen, continue to be used for the production of small moulded insulations where finish is not important or price rules out other types. The very cheapest type of pressed or moulded insulation is usually compounded of these products. The newer types of plastic moulding powders have ousted this class in many fields, but where high heat resistance is required on that occasion for outside insulation, such as strain insulation, telegraph and telephone pole insulation, they still have an extensive application chiefly on account of price.

The casein plastics continue to find extended applications chiefly for decorative purposes, and the combination of casein with other plastics such as phenol-formaldehyde resins has been successfully tried and such a product has found practical although limited application.

The synthetic resin plastics can still claim the honour of topping the list in number of patents taken out during the year, although the applications have shifted from the older, that is, the phenolic type, to the newer, that is, the urea, thiourea, glyptol and styrol types. The phenol-aldehyde resin plastics still represent the largest output of this group in tonnage production while the synthetic resin group can claim second place in total tonnage production during 1932. The more recent developments of this class of material have been the field of air drying varnishes as protection coatings. While

[1] *Development in Plastics*, by H. V. Potter, B.SC., F.I.C., *Chemical Age*, **27**, 705, 1932.

they have certain drawbacks in respect to light resistance, their resistance to moisture and sea air is a great advance on any other type of resin finish. Judging by the patent literature, investigations are following the lines of maintaining their valuable resistance to weather but overcoming the darkening to light. The application of this class of synthetic resin into the abrasive wheel industry has enabled peripheral speeds of grinding wheels to be attained which have not been possible before. High speed snagging and cutting by abrasive wheels is only in its infancy in England, but in the United States very large developments have taken place in recent years along these lines and England is only waiting for the industrial revival to install the special machines which are necessary for running at high speeds.

The largest application for the phenol resinoids and the urea resinoids consists in the field of moulding. This development still continues unabated into new fields of application and it is difficult to find an industry into which synthetic resinoid mouldings have not obtained a footing. Some of these are the toy industry, constructional and building, decorative industries, electrical and engineering and packing trades, to mention only a few. Glyptal resins made from glycerol and phthalic acid have been slow in their development until the last year or two but are now finding extensive application in the paint and enamel industry. For this application the resin or its ingredients are usually reacted with tung oil to give a relatively pale resin which is oil soluble and has the advantage of permanence to light while showing good resistance to weather. They have proved to be a useful addition to the resinous ingredients available for paint and enamel manufacture and enable the ever-increasing demand for faster drying finishes to be met. Apart from this application, and these resins are useful as a bonding material for micanite sheet and tube insulation, they have not shown any marked development in other directions so far. This may be on account of the slowness with which they are converted to an insoluble and infusible stage. There does not appear to be any relatively sudden chemical change from the fusible to the infusible state comparable with the phenol or aminoresinoids, the change being gradual over a prolonged period and most likely involving a continuation of the metal reaction, and not a second chemical reaction such as takes place with the phenol type.

The urea and thiourea formaldehyde resins referred to as "aminoresinoids" have continued to attract investigators, technicians and industry during the year. They have their field of usefulness which, at present, lies particularly around their decorative value. They are not darkened by light and are practically water-white in contrast to the phenol resinoids. They have drawbacks in other directions, however, and their higher affinity for moisture renders them less suitable for insulation. Some work has been done on combining these resins with other types, such as the phenol resins, to render them more water- and moisture-proof, but without serious success so far. Development in the field of laminated decorative sheet has been carried on and one British company, much to its credit, supplied some of the wall decorations for the studios at Broadcasting House in sheet form in a very delicate colour which is not possible so far in any other type of synthetic resinoid. If the amino plastics could be rendered more weather-resistant or the phenol resinoids more light-resistant then the future possibilities of these materials would be increased many times.

The last, but not by any means the least, important group of plastics are the cellulose ethers and esters which may be spoken of as "cellulose plastics". Reference has already been made to celluloid which falls into a class of its own; the others are cellulose acetate and benzyl cellulose plastics. Both these products, by incorporation of suitable plasticisers soften under heat and pressure and are of the thermo-plastic but not thermo setting type, such as phenol, amino of glyptal plastics. They, therefore, must essentially be handled by the ordinary method for such plastics, that is pressing hot and cooling before ejection or by a special method which has been derived recently called "injection" moulding. In this process the cellulose plastic is placed on a closed steam jacketed cylinder, with a plunger at one end and a fine nozzle at the other to which the mould containing the desired shape of the finished article is attached. The material while hot and plastic is forced into the mould under pressure, the latter being kept cool. The nozzle is then closed and the mould opened and the moulding ejected in its finished state. This method of production of mouldings is very quick, and the equipment

relatively inexpensive, but until the cellulose plastics can be manufactured cheaper the application is limited to special uses where other plastics cannot be used. There is, however, a great possibility for this type of moulding and new developments may be looked for.

The manufacture of plastics is essentially a chemical industry and has thus followed in most cases routine chemical methods of manufacture. The utilization of plastics in various other industries is more allied to engineering than chemistry. On this side more ingenuity and development along specialized lines have been shown. While the hydraulic press has been available for many years the type and construction and general layout has been radically changed to meet the needs of the plastic moulding industry. There is, however, room for more development on the lines of continuous operations to cut out the large amount of handling that is still required. There has been very little real novelty in design of finished plastic products. The industry has grown so rapidly that plastics in most instances have only substituted some other material. The past rate of development cannot be expected to continue on these lines.

Plastics can now be obtained in so many forms and colour. Celluloid in sheet and moulded casein likewise is procurable in very beautiful colours. Synthetic resinoids are available in every conceivable type of moulding of dark, warm hues to pale colours, transparent or opaque, in sheet form or panelling, constructional, electrical and mechanical uses, while the cellulose plastics show promise of development into channels where the others cannot reach, such as for pens, pencils, small articles in colour effects quite characteristic of their own.

Virus Diseases of Plants.

At a Joint Session of the Sections of Agriculture, Chemistry and Botany of the Indian Science Congress, a symposium on "Virus Diseases of Plants" was held during the Science Congress Week at Patna. Dr. S. L. Ghose presided over the meeting.

The subject was discussed under the following heads:—

Symptoms.

Morphological. [*M. Sreenivasaya.*]

The reaction of the plant to virus invasion manifests itself in diverse morphological transformations. The plant organ that is most easily susceptible and suffers the most distinctive and perceptible change, is the leaf; next comes the other aerial parts of the plant while the root is, generally, not visibly affected in the earlier stages of the disease, although this is affected in advanced stages. Symptoms at the root, however distinct and infallible, do not afford us a ready and easy method of diagnosis. It is fortunate, therefore, that the leaves of the plant are the first to suffer and exhibit the symptoms in a very decisive manner. We are thus in a position to recognize the malady at comparatively an early stage.

The symptoms generally appear with the vegetative growth and development of the affected plants; they rarely occur in tissues that are mature before infection. "Spike" of sandal appears with the bursting of dormant buds or at the growing points, as the case may be, and the general manifestation of the disease in forests synchronises with a season when the sandal plant passes through its vegetative phase of development.

Virus diseases are usually systemic in character but in the case of the higher woody plants, like sandal, the infective principle is confined to certain tissues and portions of the plant in the earlier stages of the disease. One-sided involvements with one-sided response to the effects of virus invasion, is not uncommon. Sandal spike and peach yellows afford striking examples of this phenomenon.

Mottling, chlorosis, necrosis, proliferation, dwarfing, curling, crinkling or corrugating, bunching, phyllody and sterility are some of the main symptoms which characterise virus-affected plants. The symptoms vary with the variety of the host affected. The leaf roll of potato, for example, which affects a large variety of potato plants, is accompanied in the case of the "President" variety by a pinkish discolouration of the leaflets. Most of the virus diseases stimulate starch production in affected tissues and this deposition lends the tissues a characteristic stiffness and brittleness.

Mottling is characteristic of the several mosaics, curling and crinkling, of the several leaf rolls and streaks, while dwarfing or stunting appears to be a general effect of all the virus infections. In some instances the "dwarfing" is so intense and general that the new flushes of growth result in "bunching" which is to be found, not only in sandal "spike" but also in the so-called "spikes" of *Vinca rosea*, *Z. oenoplia*, *Dudonea viscosa* and a number of other plants.

The "reproductive activity" of the plant is more or less affected in the case of virus-infected plants. The fruits become very small as in the case of cucumber mosaic, while in yet other instances the infection causes a complete sterility as in the case of sandal spike. In some cases the flower retrogrades to the leaf stage resulting in "phyllody"; this phenomenon is to be found in sandal and *Vinca rosea* spike.

The root systems of diseased plants are stunted; whether this is due to virus infection or to the diminution of nourishment from the top which

results from a congested, starch-clogged transport system, has yet to be determined.

Finally, attention should be drawn to cases of plants which do not show the symptoms in spite of their being infected. Symptomology of such disease-masking plants is not yet developed. In view of the fact that these constitute effective sources of infection, their detection with a view to their eradication is of paramount importance. Methods for detecting these plants, with reference to sandal spike, are now being developed at the Indian Institute of Science, Bangalore.

Cytological. [*M. J. Narasimhan.*]

During recent years, investigations on the cytology of plants affected by virus have shown that certain changes occur in the virus-affected cells. (i) The chloroplasts in the diseased cells have been found to undergo disintegration and in some cases have been reported to be loaded with starch, as in potato leaf roll and spike disease of sandal. (ii) In the case of the potato leaf roll, the phloem cells have been found to suffer from necrosis, involving the collapse of the cell walls, and affecting the function of the sieve-tubes. Phloem necrosis has been observed only in very few cases. (iii) The claims of some investigators that they have detected flagellate organisms in the tissue of the affected plants, have not been confirmed by other investigators. (iv) Cytoplasmic inclusions associated with animal virus diseases, such as rabies, fowl-pox, etc., which have been regarded to be of diagnostic value have been observed in some of the plants affected by virus. The nature of these inclusions was discussed, illustrating them with reference to the inclusions found associated with the spike disease of sandal, a serious virus disease prevalent in South India, especially in Mysore. The analogy of the inclusions found in sandal spike, with the Bollinger bodies of fowl-pox, in regard to staining reactions was pointed out.

Transmission.

Vector Transmission. [*T. V. Subramaniam.*]

It has been definitely established that insects play a very important part in the transmission and dissemination of virus diseases of plants.

The biological study of the subject has received considerable attention in foreign countries by numerous workers so that at the present day we have to record about 50 plants belonging to 27 Natural orders—some of them being of very great economic importance like sugarcane, potato, tobacco, etc.—known to be subject to virus attack of which many have been found to be transmitted by insect agency.

Among the insects noted as transmitting virus diseases in plants, insects with suctorial mouth-parts have been found to be more concerned than those with biting mouth-parts. Among the former, the family *Aphididæ* occupy the foremost rank as vectors of virus diseases with 27 to their credit.

A number of salient facts, *viz.*, the incubation period, period passed by the virus principle in the insect vector, presence of the inclusion body in the insect vectors, inheritance of the transmitting power by the insect vectors, length of time necessary for the insects to feed before they are capable of transmitting a disease, production of different symptoms when a virus is transmitted by insects and inoculation, etc., have to be considered in this connection.

Very little work has been done in India, excepting the work of Uppal showing the close association of the mosaic of (Chillies) Capsicum and Thrips.

In connection with a study of sandal spike, the sandal fauna of the spiked and healthy areas has been worked out. Attempts to find out the insect vector or vectors of the disease have not been a success as yet.

Artificial Transmission. [*M. Sreenivasaya.*]

Sap injection or inoculation and tissue transplantation are the two methods employed for transmitting virus diseases of plants. In many cases, *e.g.*, sandal spike, peach yellows, bunchy top of bananas, etc., sap injections have not transmitted the disease. A living support or carrier is perhaps necessary for maintaining the infectivity of the causal entity which appears to be rendered innocuous once it is freed from the live tissue. This is analogous to certain enzymes like *glycolase* which do not function when they are extracted from their associated tissues.

Tissue transplantation includes scion grafting, budding, patching and leaf insertions; it involves the insertion of a piece of infective tissue, freshly derived from a diseased plant at the susceptible region, in a manner that it will intimately fuse with the operated stock.

In transmission work, a due recognition of the susceptible region of the stock and infective tissues of the diseased plant is necessary. Ignorance of these facts have been responsible for the many failures of disease transmission cited in literature. If the infective material sap or tissue is not introduced into the susceptible region, the disease will not be transmitted. In the case of sandal spike, the disease cannot be transmitted if the infective tissue is transplanted at the root or into the wood, while successful transmission can be effected when the infective material is transplanted between the bark and the wood.

The technique of disease transmission in vogue is very crude as compared with those natural to vectors. Needle inoculation which represents the nearest approach to injection by aphids is still unsatisfactory. The natural intake of sap by the aphid is selective; laboratory preparations of sap constitute a mixture of various cell saps. The vector is further capable of injecting the infective sap into the susceptible region. The laboratory methods do not lend themselves to these requirements and sap injection in many cases are therefore unsuccessful, assuming for the moment that the role of the vector is to effect a mere mechanical but selective transfer of the infective sap.

An interesting case of tissue transplantation employed for disease transmission is that of leaf insertion in the case of sandal spike. Here is an instance of how by a judicious choice of the most infective tissue and the highly susceptible region, disease transmissions could be achieved with a very high percentage of success.

Reference may be made to root transmissions effected in the case of sandal plants where mutual parasitism is very common. A curious instance of a sandal plant which had made its connection with a grafted sandal plant getting spiked before the latter exhibited the symptoms, has been noted.

Properties.

"In Vitro" Cultivation of the Virus Principle. [*S. V. Desai.*]

It was found that the virus of sugarcane mosaic does not act as bacteriophage on organisms associated with the pest or present in the soil. Attempts to isolate organisms from diseased tissues on special nutrient agar, resulted in the growth of transport plaque-like colonies of a pleomorphic character. Healthy tissues similarly treated did not yield any organism. Subsequent culturing on agar and in broth did not affect their morphological characters. It was not found possible to free the organisms from the bacteriophage supposed to be associated with them.

A suspension of the organism was treated with a small inoculum of the virus, and incubated for five days. The filtrate obtained after passing the culture through a sterile filter candle was used for inoculating a fresh suspension of young organisms. Several passages of the virus were thus carried out to see if the virus multiplied during the serial transfers.

Inoculation experiments for the reproduction of the disease were carried with the suspension of these serial transfers. The inoculum used contained the virus principle diluted to $1:10^{16}$, $1:10^{30}$, $1:10^{44}$, far outside the limits of infective dilutions. The inoculated plants reproduced the original symptoms of the disease showing thereby that the virus principle multiplied *in vitro* either with or at the expense of the organism.

The same type of organisms were reisolated from the plants in which the disease was produced artificially.

Bacteria in Relation to Virus Diseases. [*N. V. Joshi.*]

The failure to get uniformly successful inoculations from organisms isolated from plants affected with some of the more common forms of virus diseases was regarded as proof that the diseases were not of bacterial origin and this has deterred a systematic investigation of the diseases from the bacteriological side.

However, ideas about the life cycle and morphology of bacteria under different cultural conditions have changed and are changing. Not only have many bacteriologists established that bacteria pass through a life cycle and under different conditions may exist in different visible forms, but recently Hauduroy in 1929 and Hadley in 1931, by adopting new methods, have been able to show a filterable stage in the life-cycle development of bacteria, and Swezy and Severin (1930) have shown indications of the existence of filterable forms of bacteria in the beet-root affected with curly top disease and the leaf-hopper that transmits the curly top of beets.

In the bacteriological laboratory at Pusa the mosaic diseases of several plant hosts have been studied (1931 and 1932) and cultures of bacteria from different plants affected with mosaic have been successfully isolated. Inoculation experiments with some of these cultures have been successful in reproducing all the symptoms of the virus diseases. In studying the cultures of these bacteria, the life cycle of the organisms was tried to be followed. After filtering the cultures through L-3 candles sometimes a growth could be observed and the slides were made from the smallest granules to the usually larger sized organisms. One of the organisms that was being examined happened to be a flagellated bacterium; on staining, the small granules were found bearing flagella in the same way as the larger sized bacteria. This is perhaps the first time that such an observation is recorded. The fact that the growth in the filtrate when inoculated on agar gives the same kind of growth as the original culture shows that there is a filterable stage in the bacteria that have been studied.

There appears to be very little difference between visible bacteria and the viruses. The dividing line between them is one of size only. It is necessary to examine the possibility of the existence of filterable forms of bacteria more thoroughly as one of the possible methods of arriving at a solution of this perplexing problem of the nature of virus diseases.

General. [*A. V. Varadaraja Iyengar.*]

Absence of easily recognizable and usually associated plant pathogens like bacteria, fungi and protozoa in virus-infected plants led to the suspicion that the diseases are caused by soil deficiency; the effect of fertilizers was therefore investigated by earlier workers in the case of peach yellows, tobacco and tomato mosaics, and sandal spike, but without any significant results.

Moisture and ash contents of diseased plants are generally lower than those of healthy, thus pointing to a poor absorption of the essential nutrients from the soil. Among the ash constituents, lime is conspicuously low in the diseased leaves of peach and sandal. This deficiency could not be traced to the soil.

Abnormal starch accumulation appears to be a general characteristic of all virus-infected plants, *e.g.*, tobacco mosaic (Wood and Hunger), potato leaf roll (Esmarch), spinach blight (True and Hawkins), false blossom of crawberry, peach yellows and sandal spike. A detailed study of the starch content of spike leaves of sandal has shown that it increases with the progress of the disease. In early stages, however, the twigs have been found to contain more starch than leaves. Esmarch ascribes this phenomenon to defective translocation of photosynthetic products of the leaf. Neger, in his study of potato leaf roll could not correlate the degree of rolling with starch content.

Significant conclusions cannot be drawn with regard to the other carbohydrates occurring in the diseased condition.

A physico-chemical study of the tissue fluids in the case of sandal spike and curly top of sugar beets, has been carried out.

Nitrogen Metabolism. [*Y. V. Sreenivasa Row.*]

Significant changes are brought about in the nitrogen metabolism of all virus-infected plants. In his studies on the mosaic of sugar beets, Bonequet drew attention to this aspect of the problem. Nitrites and ammonia nitrogen were found to occur in larger quantities in the diseased leaves. He concluded that the internal bacterial flora were responsible for the reduction of nitrates to nitrites and ammonia; these results found confirmation in his work on potato mosaic. A systematic study of the nitrogen distribution in the tissues of healthy and blighted spinach was carried by Jodidi, Kellog and True, who found higher

concentrations of nitrite and ammonia in the diseased condition.

In the case of sandal spike, however, a study of the nitrogen distribution has revealed (*a*) an increase in the water soluble nitrogen, (*b*) a higher concentration of the basic fraction, and (*c*) an increase in the amino-nitrogen. Further analysis of the basic fraction has shown an abnormal amount of histidine in the diseased condition, leading to the significant suspicion that histidine is getting decarboxylated with the production of histamine, a compound known to inhibit the growth of roots. The low percentage of arginine in the basic fraction in spiked leaves is equally noteworthy, as it explains the general suppression of reproductive activity with the progress of the disease.

Enzymes. [*B. N. Sastri.*]

Significant disturbances in the enzyme make up of plant tissues accompany the onset of virus diseases. It was believed at one time that the causal entity of virus diseases is of the nature of an enzyme, a theory which has recently been supported by the work of Vincent on tobacco mosaic.

Diastases and oxidases are the two groups of enzymes that have received wide attention; an increase in diastatic activity has been found in the diseased leaves of sandal, and *Dudonea viscosa*. High oxidase and a low catalase activity have been recorded for most of the mosaics. The curly top and curly leaf of beets also exhibit a high oxidase activity.

The disturbance in the enzyme balance has been brought about by subjecting the organism to unfavourable environmental conditions. Drought and over-watering, for example, have been found to develop abnormally high oxidase activity. Starvation of cells has been found to stimulate the development of enzymes.

High diastase activity, optimum reaction and lower moisture content of the metabolic fluids are significant factors influencing rapid synthesis of starch in the diseased leaves. The occurrence of the liquefying component of the diastase in low concentration hinders the rate of translocation of the products of photosynthesis leading to an abnormal accumulation of starch in the diseased tissues.

The high percentage of amino nitrogen present in the tissue fluids of the spike leaf, suggestive of the enzymatic degradation of the leaf proteins, points to a greater activity of proteases in the diseased tissues. As in the case of other virus-affected plants, a high oxidase activity is shown by the tissues of spiked sandal. Respiration studies show that a high oxygen intake and low carbon-dioxide output are characteristic of diseased tissues. It is, therefore, clear that the oxidation-reduction mechanism is upset in the pathological condition and this explains the occurrence of mannitol and accumulation of organic acids. The discussion centres round the concentration of respiratory pigment cytochrome. An insufficiency of this favours fermentative processes leading to the formation of alcohols. Incomplete oxidation of sugars results in the production of free acids which accumulate in the tissues owing to the lack of sufficient quantities of lime for neutralization.

Control Measures. [*A. V. Varadaraja Iyengar.*]

Control measures consist of (1) introduction of resistant varieties, (2) removal of infection centres, and (3) elimination of the carriers of infection.

The existence of resistant varieties is known and can be evolved either by selection or hybridisation. In the case of parasitic plants like sandal the possibility of building up resistance through host plants may be indicated.

The basic control method must aim at the eradication of the sources of infection. This requires a decisive method for diagnosing the disease which, in the case of sandal, is complicated (1) by the fact that the plant under certain environmental conditions exhibits symptoms analogous to spike, and (2) by the presence of disease-masking plants. The symptomology of these two classes of sandal plants are being worked out.

In practice a complete eradication of the diseased parts of the plant necessary for the control of infection is difficult and expensive, but this is the only method adopted in the case of the diseases of the peach and the leaf roll of potato. A similar method has been adopted in the case of sandal spike but with this modification that the plant prior to its uprootal is treated with an arsenical preparation, "Atlas", which has greatly facilitated the operation.

Eradication of wild hosts of the same species has been found necessary in the case of the cucumber mosaic.

Discussion.

Referring to the studies of transmission by insect vector, Mr. A. V. Varadaraja Iyengar spoke on the work that is being carried out at the Indian Institute of Science, Bangalore, by Mr. Cedric Dover and his collaborators in connection with the spike disease of sandal. Elaborate work on the sandal fauna, although forming a unique contribution to South Indian Entomology, has not yet yielded any positive result by way of establishing the vectors.

Dr. Gilbert J. Fowler speaking on the work carried out at Pusa, pointed out that the danger of organisms growing through the filter candles is great unless scrupulous attention is devoted to aseptic conditions of experimentation. This factor is generally overlooked.

Mr. B. N. Sastri was of opinion that the bacterial nature of the virus principle can be disputed on the basis of its resistance to several powerful cytolysing agents such as toluene and acetone.

Prof. R.H. Dastur, referring to the physiological studies, said that all the observed results are consequential to the virus attack and inasmuch as they do not give any clue as to the cause they are only of limited value.

B. N. SASTRI.
M. SREENIVASAYA.

The Science of Optics in the Service of Chemistry.

THE Indian Chemical Society held its ninth annual meeting at Patna on January 3, 1932, when Prof. B. K. Singh, the retiring President, delivered a very interesting address. Dr. Singh prefaced his address with a brief account of the origin and development of the Indian Chemical Society during the years 1924—1932. The increase in the number of fellows (from 101 to 360), subscribers, and exchange journals, the larger size of its own journal and the Society's general financial conditions all showed a steady progress. The Society conferred its honorary fellowship on two eminent scientists, Prof. A. Sommerfeld and Sir C. V. Raman and arrangements have been made to present to Sir P. C. Ray, in celebration of his 70th birthday, a commemoration volume with an address, as a token of esteem and love from the Society. The President concluded this part of the address with an appeal for funds for the permanent housing of the Society and the provision for a whole-time paid editor.

The main address was a lucid exposition of optical methods in the service of chemistry which contained an excellent summary of the Professor's own work carried out at Ravenshaw College, Cuttack, on the optical dispersion of organic compounds. Refraction, absorption and optical activity have been studied by chemists for over a century and have rendered signal service to the progress of chemical theory. During the early days of spectroscopic work, the interest of the chemist lay chiefly in the assignment of spectral lines to elements and compounds responsible for them. Bunsen, Kirchoff and Herschel were among the notable pioneer investigators in this field. The material to be examined is introduced into an arc or into a condensed spark and the spectrum photographed over the wave-length range 7000–2000 Å. Spectroscopic methods for quantitative analysis have been an attractive field of research by chemists since the days of Hartley in 1884. The most satisfactory methods in this field are due to de Gramont and Meggars who utilized the variation in intensities of spectral lines. The methods are of special value when estimating abnormally small quantities of material. The absorption curves of substances have been widely used in elucidating the structure of compounds. They form a very important source of information we possess on questions of structure.

Raman spectra, the most recent discovery, promise to provide more accurate knowledge of the structure of molecules than any other spectral method. On passing a beam of mono-chromatic light into a liquid and observing the scattered light, in addition to the simple line frequency present in the original beam, Raman found a number of very faint lines, the frequencies of which are related to the frequencies of vibration of atoms in the molecule which does the scattering. Raman spectra have been observed with gases, liquids, crystals, or glassy solids. One of the many interesting results arising out of the application of Raman spectrum is the detection of the inhomogeneity of hydrogen.

The phenomenon of optical activity depends upon the property which certain substances possess of imparting a twist to the plane of the polarization and was first discovered by Arago in 1811. Biot's pioneer work on the optically active organic compounds led to the discovery of molecular disymmetry by Pasteur. It was recognized by Biot quite early that optical dispersion is a more characteristic property of substances than optical rotatory power. He divided active substances into two types according as they obeyed the law of inverse squares or showed deviations from it, but it was not long before he began to suspect that his law was not rigorously exact. In 1898, Drude making use of the electronic theory of radiation expressed the variation of rotatory power with wave-length by means of the general formula $\alpha = \Sigma \frac{k_n}{\lambda^2 - \lambda_n^2}$. Lowry showed that these equations are adequate to determine the exact forms of the dispersion curves. He called the dispersion simple when one term of Drude's equation is sufficient and complex when two or more terms are employed. Drude's equation applies only to transparent media and not to absorption regions studied by Cotton in the region of the Cotton effect. The experimental determination of optical dispersion has been rendered easy by the introduction of new sources of light such as the enclosed mercury and cadmium arc lamps. For work in the ultra-violet region, the methods of Lowry and of Cotton and

Descamps are the most noteworthy. Lowry has also developed a method for the infra-red region, using a Nernst lamp to illuminate the infra-red spectrometer which carries a thermopile in its eyepiece. A large number of secondary alcohols, oxymethylene camphors and their condensation products with aromatic amine compounds show simple dispersion proving that the type of dispersion is independent of the number of asymmetric carbon atoms. The dispersion of camphor, monoacetyl *p*-phenylene-bis-amino camphor and other derivatives of camphor is complex and show the three characteristic anomalies—an inflection, a maximum and a reversal of sign. One more example of the importance of optical methods in chemistry is the recent announcement of Kuhn, Braun and Freudenberg of instances of successful asymmetric synthesis by application of circular dichroism. By exposing the ethereal solutions of racemic ethyl α-bromo-propianate and α-azido-propionic acid, to light λ=2800-3000 Å, optically active substances have been obtained. Though the range of activity obtained is small, the fundamental problem of asymmetric synthesis appears to have been solved in principle.

B. S.

Research Notes.

A Manometric Analysis of the Metabolism in Avian Ontogenesis.

J. NEEDHAM has determined by manometric methods (*Proc. Roy. Soc. Lond.*, Ser. B. **112**, No. 775) the normal respiratory quotient of the chick embryo in the first week of its development and finds that for the first two days the respiratory quotient is more than unity while from the second to the sixth day, it is nearly one. After the sixth day it tends to fall to 0·6. The action of certain reagents on the respiratory activity of the blastoderm, the embryo and the yolk-sac has been determined. It is found that flouride has an inhibiting action on the respiration of the embryo only in higher concentrations while the respiration of the yolk-sac and the blastoderm is affected even by lesser concentrations. The inhibition, however, is reversible, by addition of lactate. The action of iodoacetate is similar even with milder doses. Only partial inhibition without any change in the respiratory quotient is noticed with phenyl-methane. Malachite green and cyanide are comparatively very strong in their action.

The Solubility of Water in Granite Magmas.

THOSE interested in the study of the volatile constituents of magmas, which are known to play an important part in volcanology, ore-deposition and other igneous phenomena, will welcome the paper on "The solubility of water in Granite magmas"—recently published in the *American Journal of Science* (Dec. 1931). The author believes that many debatable problems of volcanology will be readily solved if we know how water dissolved in magmas behaves at different temperatures and pressures. A detailed account of the experimental work done in the investigation of this problem has been given in the paper and data are presented on the solubility of water in granite glass as a function of pressure from 500–4000 bars at 900°C. and as a function of temperature from 600°–1200° at 980 bars. Reasons are presented for considering the possibility that granite magmas may have had a relatively high water content.

Electro-Optics: Part Absorption in the Region of Soft X-Rays

[F. G. Chalklin and L. P. Chalklin, *Compt. Rend.*, 1932, 374.]

RAY has measured with $K\alpha$ (Cu), Ni $K\alpha$ some diffuse rays with lowering of frequency corresponding to the spectral terms of the absorbent.

Lines similar to those obtained by Ray have been obtained by Majumdar who employed monochromatic radiations $K\alpha$ (Ni), $K\beta$ $K\alpha$ (Fe) the absorbents being nitrogen, carbon and aluminium. Further Bhargava and Mukerjee by passing $K\alpha$ (Cu) through paraffin have obtained a diffuse line whose frequency is less than that of the incident radiation by $\Delta\nu$=R. This effect has been attributed to partial absorption of quantum by an atom of hydrogen from which an electron has been completely expelled. These savants by passing the $K\alpha$ (Ag) radiation through a foil of Ni have also observed a sharp discontinuity on the short wave-length side. The difference between the $K\alpha$ of silver and

the sharp discontinuity has been found equal to the energy of the K absorption discontinuity of nickel.

On the contrary, Lindsay, Alichanow and Arzimowic as well as Thibaud and Cork have not obtained any displaced line.

All these contradictory experiments have been performed with waves having wave-length of the order of about 1 Å. We have thought of looking for the modified line in the region of soft X-rays with the aid of a technique which is very different from those of the savants cited above.

By using a vacuum spectrograph with a grating in which X-rays were incident tangentially, we have examined the spectra of many elements. On the majority of plates one observes the $K\alpha$ line of carbon. The carbon is deposited on the anticathode by decomposition of the vapour of carbides of hydrogen which are liberated from joints and seals of the spectrograph. We find upon the plates where the $K\alpha$ line of carbon is very intense a line which is very diffuse on the long wave-length side. This appears whether the anticathode is made up of platinum, palladium, or copper. The visual inspection of numerous plates reveals that the intensity of these lines increases with that of the $K\alpha$ line of carbon and moreover it is seen very clearly upon the plates on which there is no other radiation except that of carbon. One can conclude that the effect is due to carbon. The diffuse character of the line indicates that we have not to deal with ordinary line, because such diffuse character is not observed in the usual X-ray lines except in the case of $K\alpha$ line of still lighter elements, and the wave-length of the line shows that it cannot be due to these elements.

We have observed the effect in the second order. The effect has also been observed with the aid of two gratings ruled with Siegbahn's machine of which one has got 600 lines, the other 300 lines per mm. It has been obtained under different angles of incidence and it is clear that the effect is not due to any fault in the adjustment of the apparatus.

The wave-length 51Å corresponds to 242 electron volts. It is less than the excitation voltage of $K\alpha$ line of carbon by 35 volts. It is evident that the ray cannot be due to any transition in an atom of carbon but is due to a secondary process.

By the photoelectric method it has been found that the ionisation potential of L level varies from 35–40 volts and by the Spark Spectrum method of Millikan a value slightly higher than 34·2 volts has been found. We arrive at the conclusion that our diffuse line is due to the expulsion of an electron at the L level by a quantum of radiation $K\alpha$ with the loss of a part of its energy. If one admits the correctness of the process, $h\nu$ of the modified line should be $h\nu K\alpha - W_{L\rightarrow\infty}$ This frequency corresponds to the energy 242 volts which is in very good accord with the observed value. That there is a veritable evidence of absorption is the proof that we obtained also the discontinuity of carbon on the same plate. The wave-length which we obtain agrees very well with the first determination by Thibaud, *viz.*, 284 volts. It is probable that this discontinuity is the result of a process where a K-electron passes to the first empty level at the exterior of the atom. This inclines us to the supposition that it may be the passage of an electron from the occupied L shell to the next vacant level (due to $K\alpha$) which gives rise to our line.

It is necessary to note that in the case of discontinuity of absorption, the incident radiation forms a continuous spectrum, while the exciting radiation of our modified line is monochromatic. Nevertheless, an effect due to a shifting by this space is admissible. In such a manner one can explain easily the broadening of the $K\alpha$ line of carbon in the direction of the long wave-length as observed by Prins, as well as by ourselves. On our plates we observe a blackening of plates beginning from the $K\alpha$ ray of carbon up to the diffuse line.

We have also to notify the discovery of a further discontinuity at 39·7Å corresponding to 311 volts. We believe that it results from the complete expulsion of the electron and it gives us a correct measure of the value of K level. We conclude that the excitation potential of $L\rightarrow\infty$ is equivalent to 311 — 277 or 34 volts, which is in good accordance with the observed values.

Studies on the Hypophysectomised Ferret.

MARGARET HILL AND A. S. PARKES in a series of three interesting articles (*Proc. Roy. Soc. London*, Ser. B, **775**, 1932) describe the surgical technique for hypophysectomy, the spermatogenesis of the thus treated individuals and also the effect of post-coitus hypophysectomy on ovulation and the development of the corpus luteum. The

authors describe in the first part the methods adopted in exposing the pituitary body, after anaestethising the ferret; the basisphenoid bone is drilled and the pituitary is removed by the application of a glass suction pippette. A series of precautions to ensure a successful operation are reported. The second part deals with the spermatogenesis in individuals that underwent the operation. The testes of the hypophysectomised ferrets were removed at different periods and were sectioned and studied. The testis of a normal ferret was also studied as a control The conclusion of the previous workers like Smith, Reichert and Wislocki is that the reproductive tract in the male atrophies after hypophysectomy. The observation on the ferret is in accordance with the results of the previous workers. There is a definite regression characterised by decrease in weight of the testis and by aspermatogenesis. The experimental regression is about three times as rapid as the normal decline into anaestrum. The ferret is definitely known to ovulate after copulation. The effect of hypophysectomy on the animals is to inhibit the growth of the corpus luteum and the animals fail to become pregnant after hypophysectomy before ovulation.

A Genetical Formula for the Inheritance of Intelligence in Man.

DR. C. C. HURST has published (*P. R. S.*, B, **112,** 775, 1932) an interesting paper on the results of his investigations on the inheritance of the natural mental ability of a large number of Leicestershire families and also on the independent statistical material presented by F. A. Woods of Boston. These investigations using the statistical methods were first undertaken by Galton and his method and conclusion have been greatly elaborated by Pearson in England and Woods of Boston in America. Dr. Hurst's results are best given in his own words:

"Two diverse sets of material have been used in the investigation of the inheritance of natural intelligence in man. (1) The L. F. data of 194 Leicestershire families consisting of 388 parents and their 812 offspring, individually studied by the author. (2) The R. F. data of the Royal families of Europe consisting of 212 families including 424 parents and their 558 offspring, statistically studied by Woods (1906). The concept of general intelligence is defined. Following Galton (1869) and Woods (1906) individual parents and offspring have been graded for intelligence, on their general mental achievements, in 10 equal grades, from the highest grade 10 to the lowest grade 1. The grades are characterized as follows:—10, illustrious; 9, eminent; 8, brilliant; 7, talented; 6, able; 5, mediocre; 4, dull; 3, subnormal; 2, moron; 1, imbecile; (0, idiot). Equivalent juvenile gradings in terms of I.Q. are estimated at 20 I.Q. per grade, *e.g.*, 200 I.Q. =grade 10, 100 I.Q. =grade 5, 20 I.Q.=grade 1.

"The most frequent (grade 5) parents were found to be of three genetical types NN, Nn and nn, in which N is a dominant gene for normal mediocre intelligence (grade 5) and nn is a recessive pair of genes for abnormal variable intelligence in the presence of which any of the ten grades of intelligence may be expressed. The 10 grades of intelligence are provisionally referred to the action of five pairs of minor genes Aa....Ee in the presence of the major pair nn. The dominant minor genes A....E act as equal and cumulative increasers of intelligence while the recessive minor genes a....e act as decreasers. In the presence of the dominant major gene N(NN or Nn) the minor genes Aa....Ee are inactive.

"On this basis the genetical formula for the inheritance of intelligence is hexagenic, consisting of 1 major and 5 minor pairs of genes. It may be expressed in 729 genotypical forms of which the most heterozygous form is [Nn *plus* (Aa *plus* Bb *plus* Cc *plus* Dd *plus* Ee)]."

It is concluded that the genetical formula proposed fits the diverse data sufficiently well qualitatively to be used as a working hypothesis for other families and populations on which it should be tested quantitatively on a large scale by systematic and co-operative research.

The Dartmoor Granites.

THE recent paper on "The Dartmoor Granites: their genetic relationships" (*Q.J.G.S.*, **88,** May 1932) is perhaps the most important of the series of papers published by A. Brammal and H. F. Harwood on the Dartmoor Granite—the largest of the west of England Complexes. The paper gives nearly a hundred analyses of the various types of associated rocks in this complex and all this analytical evidence is made to throw some light on the problem of granite

variation as a criterion in field mapping and as an aid to the tectonic interpretation of the Dartmoor Complex. "The outstanding feature of the article is the intensive character of the work done in demonstrating both assimilation as a fact and the *selective* nature of the reaction mechanism fundamental to the process and in establishing a bigeneric cause for the variation; the latter recapitulates phenomena prone to be regarded as due to differentiation alone, whereas it is attributed, in the Dartmoor case, to differentiation in alliance with assimilation of shales and basic igneous rocks." From their studies in this field, the authors have also discussed the problem of the origin and nature of "initial granite magma", and it is their belief that while it may be possible that granitic rest-magma may be evolved by differentiation from basaltic parent magma. this process alone, unaided by either assimilation or palingenesis, is inadequate to produce granite in batholith-bulk.

Observations on the Immature Stages of some Indian *Psyllidæ* (*Homoptera : Rhynchota*).

[Rahman, K.A., *Ind. Journ. Agric. Sci.*, **11**, 4, 358, 1932.]

THOUGH the Psyllidæ are an important group of insects from the economic viewpoint, very little is known of their biology, and common Psyllid pests are generally unidentifiable in the pre-imaginal stages. Mr. Rahman's paper is, therefore, to be welcomed as a small but useful contribution to the identification of immature Psyllids. He describes the stages of five Indian species, and offers various observations on bionomics. It is to be hoped that Mr. Rahman will continue his studies to the point of a monograph on Indian Psyllidæ.

The Institution of Engineers (India).

THE Institution of Engineers (India) was started in India about twelve years ago and is being run on lines similar to other professional Institutions in England and other Western Countries. It is composed mostly of engineers who are actually engaged in the practice of the profession. Many of the members are eminent leaders in the profession. Its headquarters are in Calcutta and a number of local centres are established in different parts of India. The Institution generally holds its annual sessions in different centres in India, and professional papers contributed by the members are read and discussed during those sessions. The privilege of membership to the Institution is a valued one. New entrants, unless considered by the Council as otherwise fully qualified, are subjected to an examination similar in scope and character to the B.E. Degree examination of an Indian University. In pursuance of this the Government of India have delegated to this Institution the onerous responsibility of controlling the standard of efficiency in all the Engineering Colleges in India and Burma, and the question of recognition of the B.E. Degree of the Mysore University was under its consideration for over four years. The President of the Institution inspected the College about a year ago.

Although Bangalore was not a centre, still the Mysore University extended an invitation to it in the year 1930 to hold its next session in Bangalore, but it declined to do so as there was no local centre in Bangalore. The invitation to hold this year's session in Bangalore was again repeated and the Institution agreed to do so on the undertaking of Mr. S. H. Lakshminarasappa, former Principal of the Engineering College, to make all necessary arrangements for the meeting. Mr. Lakshminarasappa thus took the entire responsibility and left no stone unturned to make the function a grand success. He deserves to be warmly congratulated for the untiring zeal and energy with which he shouldered and discharged his responsibilities.

The sessions lasted for four days and two meetings were held in the Daly Memorial Hall on the 16th and 17th January 1933 and two excursions were made to Sivasamudram and Krishnarajasagara on the 18th and 19th idem.

A dinner was held by the Institution at the West End Hotel on the 16th night and about sixty covers were laid. His Highness the Yuvaraja of Mysore was the Chief Guest of the evening. The President, Dr. Jardine, in proposing the health of His Highness the Yuvaraja, gave a brief history of the Institution and announced the recognition of the B.E. Degree of the Mysore University by the Institution. His Highness then made a short and appreciative speech and made a handsome donation of Rs. 2,500 towards the Building Fund of the Institution.

On the 16th afternoon and on the 17th morning some local visits were undertaken by the members to the Indian Institute of Science, the Porcelain Factory and Soap Factory, and a business meeting was held and a valuable paper on "Tunnelling in connection with the Uhl River Hydro-Electric Scheme" was read by Mr. N. V. Darofeeff, who is an Associate Member of the Institution. The meeting was well attended and a number of members took an active part in the discussions which followed.

The Mysore Engineers' Association were at home to the Members on the 17th evening and the elite of the town were present.

This opportunity was taken to form a local centre of the Institution of Engineers (India) at Bangalore, as many of the members of the Mysore Engineers' Association have come forward to join the Institution, because of the substantial financial help promised by Government.

The members expressed themselves very pleased with all that they saw in Mysore.

V. G.

Science News.

ASTROLABES are not as generally available for study in the museums of the world as their scientific importance and artistic qualities would merit, but all who may desire to become better acquainted with this instrument in its various forms are now given the opportunity. Subscribers are invited for a comprehensive work, entitled *The Astrolabes of the World*, based upon the series of instruments in the Lewis Evans Collection in the Old Ashmolean Museum at Oxford, in the British Museum at S. Kensington, and in several other public and private collections in India and America. The early Greek Treatise on the Astrolabe, by Philopon, and the Syriac Treatise by Sabokt, both dating from the seventh century will appear in English for the first time. Illustrations are given of Chaucer's astrolabe, now clearly identified by the character of the rete as depicted in MSS., and many instruments contemporary with Columbus and Drake are figured; also several important examples made at Lahore.

No such history of any other scientific measuring instrument has ever been published. The subject is of fundamental importance to all students of the history of Indian and Persian astronomy and geography and surveying, and indeed to the History of Science generally, for it may truly be said that the astrolabe kept alight the torch of the scientific method of observation, and of computation of results, in many countries, and through many dark ages, when larger instruments and well-equipped observatories did not exist.

The complete work will be issued in two quarto volumes, containing over 600 pages and 155 plates, of which 12 are in Collotype, and 216 text figures.

The price to subscribers is ten guineas. Subscription forms may be obtained from Dr. R. T. Gunther, Curator of the Lewis Evans Collection, in the Old Ashmolean, Broad Street, Oxford.

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At the second annual meeting of the Society of Biological Chemists held at Patna, on the 3rd January, the following Office-bearers were elected for the current year: —*President*—Rai Bahadur Dr. Upendra Nath Brahmachari, M.A., M.D., Ph.D. *Vice-President*—Dr. Gilbert J. Fowler, D.Sc., F.I.C. *Members of the Executive Committee*—Prof. R. H. Dastur, M.Sc., F.L.S.; Prof. H. K. Sen, D.Sc., D.I.C.; Dr. C. V. Natarajan, M.B.B.S., D.P.H.; Rao Bahadur B. Viswanath, F.I.C.; Dr. P. E. Lander, M.Sc., D.Sc.; Mr. C. S. Rama Iyer, B.A.; Dr. K. C. Sen, D.Sc.; and Lt.-Col. J. A. Sinton, V.C. *Treasurer*—Dr. V. Subrahmanyan, D.Sc., F.I.C. *Secretary*—Mr. B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc.

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Under the auspices of the Medical and Veterinary Section of the 20th Indian Science Congress held in Patna, Dr. Igor N. Asheshov. Officer-in-charge, Bacteriophage Inquiry, Indian Research Fund Association, Patna, gave a demonstration of Bacteriophage. Dr. Asheshov explained the principles of the handling of bacteriophage and of preparation of bacteriophage mixtures for practical application.

The technique of isolation of bacteriophage from different sources was explained and shown. It was pointed out that the most important fundamental rule which must be observed in working with bacteriophage is to use all the precautions necessary for isolation and maintenance of cultures of bacteriophage in ultrapure state, *i.e.*, cultures containing one type of bacteriophage, non-contaminated with another type. The Type Test introduced by the author insures the necessary control of the purity of such cultures. The application of the described technique makes a rational basic study of the properties of bacteriophage possible.

The strict application of the following rules in preparation of bacteriophage mixtures for prevention and treatment were recommended.

The mixture must contain all the known types of corresponding bacteriophage, as each type compensates the action of another.

The properties of the races of bacteriophage used, and particularly their virulence, must be thoroughly studied. This investigation at the present time is put on a rational basis by application of the Virulence Test introduced by the author.

The races of bacteriophage used for preparation of bacteriophage mixtures must not be altered by laboratory procedures, but must possess all the properties of bacteriophages met with in Nature. This is achieved by passing bacteriophage races through human organism and by the use of only freshly isolated unaltered bacterial cultures.

The mixture of bacteriophages must contain sufficient number of corpuscles of each type of bacteriophage. There must be at least 1×10^9 of each of the main types of bacteriophage in 1 c.c. of the mixture.

* * *

The Eighth (Jubilee) Conference of the Indian Mathematical Society was opened on the 21st December by His Excellency the Governor of Bombay, with an encouraging and sympathetic speech. The forenoons of 22nd and 23rd were devoted to the reading and discussion of papers; the afternoons were devoted to a discussion on the teaching of Mathematics in primary and secondary schools, in which the local teachers took part, and a discussion on the teaching of Mathematics in the University. In the latter the question of the place of rigour in University teaching figured prominently, and a suggestion to include actuarial science among the optionals for the B.A., made by Mr. L. S. Vaidyanathan, Actuary, received a certain amount of support. There were three popular lectures on the evenings, namely:

"The Present Crisis in Dynamics" by Prof. Saha.

"The Nature of the Continuum" by Dr. R. Vaidyanathaswamy.

"Mathematics and Religion" by Rao Bahadur P. V. Seshu Aiyar.

The Celebration of the Silver Jubilee on the 24th was presided over by Dr. Mackenzie, Vice-Chancellor of the Bombay University. An address was presented to Prof. M. T. Naraniengar who served as the first editor of the *Journal of the Indian Mathematical Society* for over a period of twenty years. Speeches were made by the various foundation members who were present on the

occasion, referring to the history and work of the Society.

* * *

The attention of the authors of the note "On the Breeding Habits of *Gecko verticillatus*" published in *Current Science* (Vol. 1, No. 6, pp. 164-165), is invited to a previous communication on the same subject recorded in the *Proceedings of the Indian Science Congress* (1931), and we believe that omission to refer to this earlier work is due to oversight. Dr. B. K. Das, Professor of Zoology, Osmania University, who, as senior author, communicated a note first to the Zoology Section of the Indian Science Congress held in 1931 at Nagpur, further refers to this work in the list of literature he cites in *Anat. Anz.*, Vol. 73, No. 14/16, February 1932.

* * *

In connection with an article of Prof. I. Traube (*Koll. Zeit.*, **59**, 136, 1932) in which he refers to a paper by Prof. Satyendra Ray (*Koll. Zeit.*, **56**, 165, 1931) on the constants in Van der Waals' equation, and says that the approximate constancy of the ratio of the constants a and b had been noticed long before by himself in the case of liquids (*Zeit. f. Phys. Chemie*, **68**, 289, 1909) and by Prof. Bodenstein in the case of gases, Prof. Ray writes to inform us that his work was done independently of Prof. Traube's results and with the opposite purpose, *viz.*, to show the unsuitability of Van der Waals' equation, whereas Prof. Traube considered it to be a most important equation of state. With regard to Prof. Bodenstein, Prof. Ray writes that in a letter to him Prof. Bodenstein had pointed that a/b could not be a constant considering the fact that it is zero for hydrogen, helium and neon while Dewar had found a difference of 40% between ethylene and ammonia. Prof. Ray also points out that he has newly developed a theory in which it is shown that the ratio a/b exhibits atomicity apart from the approximate constancy which was noted by Prof. Traube in the case of some liquids containing carbon at 0°C. but was not theoretically deduced. Such questions of priority, however, are of no more scientific interest, writes Prof. Ray, and it may be more profitable to wait for the results that follow from his new theory.

* * *

Addressing the Deccan Merchants' Association in Bombay Sir M. Visvesvaraya laid stress on the imperative need for initiating new industries as the most effective means of relieving the present economic distress in the country. He discussed the possibilities of the future and showed how, with the necessary state aid and local effort, various types of major, medium and minor industries can be started. He suggested the creation of a National Economic Council with head-quarters at Delhi and similar organizations at various provincial centres for the purpose of conducting industrial surveys and promoting new industries. It is gratifying to note that the machinery proposed by Sir Mokshagundam is similar to the one outlined in an earlier issue of this Journal (*Curr. Sci.*, **1**, 95, 1932).

* * *

Is man ethically fit for the gifts of science? This is the subject of a thoughtful article by Prof. D. D. Kanga (*Jour. of the Univ. Bombay*, Vol. I, Pt. II, 1932), who, after showing how science has fulfilled human expectations, adduces evidence to prove how man's selfishness renders such gifts unavailable to his brethren. The motto of science is service combined with truth and it should be the endeavour of every university to teach its students a scientific outlook on life which would not only enable the latter to face the various every-day problems but also inspire them with the will to share the gifts of nature with the others, of whatever race and country, who are deficient in them, and for the common good of all.

* * *

At the invitation of the Annamalai University, Rao Bahadur B. Venkatesachar, M.A., F.Inst.P., will deliver a series of five lectures on "Atomic Nucleus and Hyperfine Stucture of Spectral Lines" commencing from the 11th February. The lectures are divided as follows:—Rutherford's atom model and Bohr's derivation of Balmer's formula: Sommerfeld's elliptic orbits and fine structure of Balmer lines; Quantum numbers and spectral terms—Selection rules; Collisions of the first and second kinds—Resonance potential and Ionisation potential—Experimental technique; Interaction between radiation and matter—The Compton and Raman Effects; Recent work on atomic nuclei including hyperfine structure of spectral lines.

* * *

Silica and Soil Nitrogen.—Mr. A. SRINIVASAN of the Department of Biochemistry, Indian Institute of Science, Bangalore, writes:—Although a large part of modern agricultural research relates to nitrogen transformations in soils, yet very little systematic work has been carried out to determine the accuracy of the methods employed in such investigations. My recent studies supported by the earlier ones of Bal in the case of black cotton soils (*J. Agric. Sci.*, **15**, 454, 1925), have shown that the various modifications of the Kjeldahl method involving digestion of dry specimens with concentrated sulphuric acid lead to inaccurate estimates, the error being, in some cases, as high as 25 per cent. The defect in the above technique is due to the formation of protective coats of silica around unattacked soil particles which thus render the digestion incomplete. The above difficulty can, however, be overcome and accurate values obtained by pre-treating soils with hydrogen peroxide, water, aqueous solutions of different acids, bases or salts, or volatile solvents. A modified method leading to (*a*) quicker and smoother digestion and (*b*) higher and more consistent values than by any of the present official methods has been developed and will form the subject of an early communication to the *Indian Journal of Agricultural Science.*

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We acknowledge with thanks the receipt of the following:—

"Nature"—Vol. 130, Nos. 3289-3297.

"Chemical Age"—Vol. 27, Nos. 698-705.

"Journal of the Indian Chemical Society"—Vol 9, Nos. 9-11.

"The Indian Forester"—Vol. 58, No. 12.

Scientific Notes of the Indian Meteorologica Department—Vol. V, No. 48:

"On Some Characteristics of the Tropopause and Upper Troposphere over N. W. India", by N. K. Sur and J. C. Roy.

Scientific Notes of the Indian Meteorological Department—Vol. V, No. 50:

"Inversions of Lapse Rate of Temperature over Karachi" by A. S. Hariharan.

Scientific Notes of the Indian Meteorological Department—Vol. V, No. 51:

"A Preliminary Study of Rainfall at Quetta" by A. K. Roy and R. C. Bhattacharya.

Annual Report of the Imperial Institute of Veterinary Research.

Memoirs of the Indian Meteorological Department "On Evaporation" by S. K. Banerji.

Reviews.

THEORY OF ELECTRICITY AND MAGNETISM. By Prof. Max Planck. Translated by Henry L. Brose, M.A., D.Phil. (Oxon.), D.Sc., Macmillan & Co, Ltd., London, 1932.

This is an English translation of the third of a series of five volumes on theoretical Physics by one of the acknowledged leaders of thought in Modern Physics. The book aims at giving a unitary exposition of the Field Theory of Electricity and Magnetism and as such its arrangement and treatment of the subject are different from what are usually found in English treatises on the same subject.

English writers usually follow Maxwell as regards arrangement and method. Electrostatics, magnetism, current electricity and electrodynamics are generally treated as separate and independent branches of science with their own special laws. They usually begin with the Coulombian Laws of force based on the hypothesis of action at a distance and though the Field Theory finds a place in every book it occupies usually a very subordinate position. Emphasis is, on the other hand, mostly laid on the experimental aspects of the subject and the wealth of details given is apt to be a bit confusing to students of theoretical Physics. It is usually towards the end of the book that the classical equations of the Field Theory are deduced through which the final synthesis and fusion of the separate domains into one homogeneous whole can be achieved. This important task is, however, very often overlooked or is usually treated in a modest and neglected corner.

The author of the book under review prefers a different mode of exposition. Being one of a series of five works on theoretical Physics the book treats the subject of Electricity and Magnetism more or less in the same way as Mechanics of deformable bodies and of continuous material media are treated in the earlier volumes.

The ultimate aim of the theoretical physicist is to bring the divergent domains with their special laws under the sway of a minimum set of general principles from which all special laws would be deduced as particular cases. Such a survey of the whole field of physics from a single unitary standpoint is as yet unrealizable, but the author here has tried to bring about the rapprochement between the distinct subjects of Electrodynamics and Mechanics, by giving the principle of the conservation of energy and the principle of contiguous action a prominent position as in the other volumes.

A plausible deduction of the Laws of Maxwell is first attempted with the help of certain assumptions about the nature of electric and magnetic energies and with the idea of the flux of energy. Once the general laws of the Field Theory are established the author deduces the special laws of Electrostatics, Magnetism, Current Electricity and of quasi stationary electrodynamical phenomena, as special consequences of the same general equations which get more or less simplified owing to the special conditions which the electric and magnetic vectors satisfy in the different cases.

The principal consequences of the laws are then worked out for each of the separate branches of the subject, and the peculiarities of conception which the Field Theory involves are discussed lucidly and in a masterly manner. This survey of the whole field from a unitary standpoint proceeds systematically through domains of increasing complexity, and ends finally with the Electro-dynamics of moving bodies where already the weakness of the Maxwellian theory begins to show, and its failures and limitations are pointed out in the last chapter where references are also given to the greater generalizations achieved in this respect in recent times.

The perusal of the book will benefit immensely the reader who has got leanings towards the theoretical side of Physics; one should, however, remain conscious of the limitations of the method and of the one-sided character of such an account.

One of the advantages of the Field Theory according to the author is that the hypothesis of this theory are of more special nature

than the rival theories based on the principle of action-at-a-distance. It is pointed out that whereas there have been different theories of action-at-a-distance in Electrodynamics there has been only one, that of Maxwell, based on the principle of contiguous action. A fewer number of undetermined constants occur in the theory than in any other. This very special nature makes the Field Theory capable of making comparatively unambiguous predictions about future events; it thus achieves more as a theory, than any other rival theories in the same field.

The method of deduction of the Field Equations which the author pursues, however, does not at all make it clear or plausible that only one unique formulation is possible of the Field Theory. Even when one accepts the principle of conservation of energy, the existence of the vector of flux and the principle of contiguous action, a large margin of possible alternative solutions still remains. The unambiguous nature of the answer expected from the Field Theory is thus not self-evident. For example, even if one accepts that the flow-vector is completely determined at every point by the electro-magnetic state it is not at all clear why this particular vector should depend on 'E' and 'H' alone and not also upon their space and time differential coefficients. There is no *a priori* objection against such a hypothesis (on the Field Theory). Exactly the same criticism might be made against the method of deduction of the fundamental equations. Maxwell's equations are not the only solution which suggest themselves of the equation (52*a*) of p. 21. It is easy to conceive of other solutions equally simple which, however, differ from Maxwell's equations in having additional terms in the right hand side of 27 (*a*) and 27 (*b*). Even the additional assumptions that in the statical case the general equations should break up into two independent sets which 'E' and 'H' will separately satisfy, will not remove the ambiguity. In fact the uniqueness of the Maxwellian theory does not follow from the general principles from which the author starts.

It is well known that various attempts have been made from time to time to deduce the Field Equations from some general Mechanical Principle like the principle of least action, and every such attempt has failed. The justification of the Field Equations in the special Maxwellian form is as yet to be furnished only by the cruci experiments. The equations thus remain u to this time a convenient empirical hyp thesis which furnishes the best fit to tl observed facts.

The empirical nature of the Field Theo is apt to be a little overlooked in an expositio such as the author has given in the boo under review. A more satisfactory and, t our mind, a more logical procedure woul have been to take the Field equations tested hypotheses and then to show as usually done in some books that these equ tions are compatible with the mechanic principles of conservation of energy an momentum if certain quantities are taken representing energies, momentum and flu vector in the electro-magnetic field.

One misses also in this book, a discussio of the Lorentz equations which preserve tl advantages of the Field Theory so admirabl and meets at the same time the demand f a hypothesis involving a discrete structu of electricity as revealed by experiment Not only do the simple equations of Maxw and Hertz prove inadequate for movir bodies as the author himself points at tl end of the book, but its unsatisfacto nature is apparent as soon as a ration theory of the dielectric or conducting med is attempted. An additional chapter c this question would have been welcome.

However much we would have liked o author to have gone further in the expositic of his subject in certain directions, the bo in its present form, presenting as it does admirably simple and masterly expositic of the Field Theory of Maxwell and Her will prove certainly of immense benefit all students of theoretical Physics. T translator of the book deserves our gratef thanks for thus making once more accessib to the students of Indian Universities really good book bearing the impress of master-mind.

S. N. BOSE.

* * *

MODERN PHYSICS. *Lehrbuch der Theoret schen Physik*, Von. Joos. Akademisc Verlaggesellschaft m. b. H., Leipzig 193 Price 14 Marks.

The bold and rapid advances which, sin the beginning of the present century, have r volutionised Physics, have also brought wi them new problems for the teacher. T wealth of material which requires to be e amined at least cursorily by every serio

student of Physics is now enormous and important additions are being made every day. To understand Modern Physics, however, a knowledge of much of classical physics is absolutely imperative and it is a difficult task to determine what should be included and what can be safely omitted. A number of attempts have been made in recent years to produce text-books which solve this problem, but in many of these the emphasis has not been properly divided between the old and the new and the two methods of approach have not been sufficiently well blended into a coherent mode of presentation. In both the balance with which the classical and modern portions have been treated and the unity of method by which the transition from the one to the other has been effected, Prof. Joos' "Lehrbuch der Theoretischen Physik" holds a position in the front rank. It is a perfectly modern book which yet conserves with reverence the heritage of the old masterpieces and knits the newer acquisitions with the old into an organic whole. In the classical portions the methods of presentation that have stood the test of time have been followed, innovation in this domain being regarded as the reverse of improvement. However, the arrangement of these has been so contrived as to provide a natural introduction to the modern developments which have been interwoven with the classical theory in an admirable manner. The power of condensation exhibited is marvellous and yet the physical principles are explained more thoroughly than would be expected from the range of topics included.

The volume is divided into seven books; the first is devoted to a brief and yet comprehensive presentation of those necessary branches of mathematics which the student at College has not already mastered. Of these, Vector Analysis occupies the larger part and is sufficiently fully developed. Introductory sketches of Tensor Analysis, Theory of Functions of a complex variable, and the Calculus of variations have been included. The theory of vibrations and waves is dealt with in a separate chapter. The second book develops the mechanics of a particle and of rigid bodies in the usual manner and chapters have been added on the essentials of the mechanics of deformable bodies and of fluids. The scope of these can be gathered from the fact that the symmetrical top, transverse vibrations of strings and membranes and Stokes' Law of the motion of a sphere through a viscous fluid and the theory of capillarity terminate the chapters on mechanics, elasticity and hydromechanics respectively. A final chapter deals with the special theory of relativity; the general theory is merely noticed in passing and its mathematical treatment has been omitted as being too difficult. The third book deals with electrostatics, magnetostatics, electromagnetics, and the electromagnetic theory of light. An account of high frequency alternating currents is also briefly given. The book closes with a chapter on geometrical optics. The fourth book treats of electrolytic conduction, conduction in gases, the elements of the theory of metallic conduction, atomistic theory of dielectric constants, refractive indices and magnetic permeability, and lastly the optics of moving media. The Debye-Huckel theory is described and Sommerfeld's theory of metallic conduction is also sketched without detailed mathematical treatment. The theory of the arc and glow discharge is given and Aston's Mass-spectrograph is described in connection with anode rays. The fifth and the sixth books are occupied with the theory of heat, the former from the phenomenological aspect and the latter from a statistical point of view. The theory of heat conduction, the equation of states, thermodynamics including the equilibrium of thermodynamic systems and applications of Nernst's heat theorem make up the fifth book. The sixth book is devoted to kinetic theory and classical statistics, Debye's theory of specific heats, theory of radiation and the Bose-Einstein and the Fermi statistics. The seventh and the last book touches upon the modern theories of atomic structure and quantum mechanics. The scattering of particles, Bohr's theory of the spectra of hydrogen and ionised helium, Moseley's law in X-ray spectra, the correspondence principle, the Zeeman effect, Pauli's principle and the structure of the periodic system and elements of the theory of band spectra, are all dealt with clearly and succinctly. The elements of wave-mechanics with applications to the Hydrogen spectrum, molecular spectra, dispersion and the Raman effect, and to Radioactive transformations are given. Some topics, not of sufficient importance to be included in the text, are given in the form of problems, hints for whose solution are given at the end of the book. One could have wished that

such topics as the theory of instruments of high resolving power, Saha's theory of thermal ionization, X-rays, radioactivity and nuclear structure might have been treated a little more in detail; but as the author says in the preface, the book is meant only to bring the earnest student to a vantage point from which the different peaks of physical knowledge can be surveyed and reached with greater ease by means of the guidance afforded. We can heartily say that this aim has been well achieved and an Honours student can desire no better book than that of Prof. Joos to give him an accurate and impartial orientation in the field of Physics. The printing and binding are of the same excellent quality as one is familiar with from the *Handbuch der experimental Physik* issued by the same publishers.

B. V.

* * *

The Form and Properties of Crystals. By A. B. Dale. Pp x+186. (Cambridge University Press, 1932.) 6*s*. net.

This little book is intended by the author to serve as "an introduction to the study of minerals and the use of the petrological miscroscope" and help the students "to master the principles underlying the examination, measurement, and identification of minerals". Though hardly 200 pages in size, the book is a successful attempt in bringing together all the fundamental ideas bearing on the crystallographic, physical and optical study of minerals, in a form which certainly helps the student to appreciate the vital connection between these different aspects of mineralogy. The first four chapters deal with the nature, classification, internal structure and the general physical properties of crystals, while the remaining two chapters are devoted to the study of the optical properties of minerals. The fundamental principles of physical optics underlying the study of thin sections of minerals in polarised light are very clearly explained and the different methods of investigation of a mineral by means of the petrological microscope have been indicated. The numerous figures and diagrams found throughout the book go a long way in helping the student to understand clearly the subject-matter.

Though small in size, the book gives such a clear, though elementary, exposition of several important aspects of the study of crystals that there is no doubt it will be found useful not only by students of mineralogy and petrology but also by students of chemistry and others to whom crystals are becoming matters of increasing interest and importance.

L. RAMA RAO.

* * *

Plane Trigonometry. By B. B. Bagi. Dharwar, 1931. Price Rs. 3.

It is very gratifying to note that, of late, a number of talented persons have been writing *Swadeshi* text-books on scientific subjects in a thoroughly modern and rigorous style. Mr. Bagi must be congratulated for his successful attempt in bringing forth a book embodying many interesting and original ideas. The book has been written with commendable care as regards mathematical rigour in the proofs and in the development of the subject. Special mention may be made of the chapter on inverse functions, whose accurate treatment by Mr. Bagi stands in contrast with that to be found in many English text-books.

The book will be a very valuable asset to all teachers of the subject, as well as to such of the students who show some ability in mathematics. Many, however, will not be able to agree with the author when he talks of "the maturer intellect and the higher level of mathematical knowledge of the students of Indian Colleges"—especially at the Intermediate Standard. Unless the book is made more interesting and less terrifying to the average student—be he of any nationality whatever—by inserting a large number of easy examples in most of the chapters, and by removing the harder ones to the end, the adaptability of the book as a *text-book* becomes difficult. In particular, the absence of chapters on solutions of right-angled triangles, and easy problems on heights and distances involving only right-angled triangles may be called a defect from the point of view of the beginner. These defects—which can be easily remedied in a second edition—do not, however, diminish the unquestionable value of the book to the teacher and to a large number of students.

C. N. S.

* * *

Metamorphism. A study of the transformations of rock-masses. By Alfred Harker Pp. ix+360. (Methuen & Co., Ltd., London.)

The author of this treatise is well known in connection with two books which have had a far-reaching effect on geological thought. One, "The Tertiary Igneous Rocks of Skye", published in 1904, was probably one of the most fruitful investigations of its

kind ever undertaken. The other, "The Natural History of Igneous Rocks," although now a quarter of a century old, can still be read with great profit by students of petrology. The book now under consideration in no way falls below the standard of its predecessors, which is high praise indeed.

The study of metamorphism can be approached from two points of view, the descriptive, which regards metamorphic rocks simply as museum specimens to be studied for what they are; and the genetic, which pays more regard to metamorphism as a progressive process, and studies the changes through which rocks have passed during their geological history. The former, rather sterile point of view, has been the one adopted by the German school of petrologists, dominated by Grubenmann and his pupils. It has tended to divorce metamorphism from its place in geology, and, as the author aptly puts it, is a relic of the Wernerian school of geology. In the present treatise it is refreshing to find the subject treated in a more rational way, and the processes of metamorphism discussed in their relation to geological history.

Grubenmann, in his well-known treatise 'Die Kistallinen Schiefer', recognizes three grades of metamorphism, which he correlates with depths within the earth's crust. But this attitude ignores the fact that during metamorphism the earth's crust is in a disturbed state, and that the temperature gradient which prevails, and controls to a large extent the grade of metamorphism, has little relation to depth. Moreover, Grubenmann took no account of purely thermal metamorphism, which, being a special case, must be considered before a clear understanding can be gained of the more general problem. In the present treatise the author first examines the changes which all classes of rocks undergo when subjected to increasing temperature, and then discusses the more general, and more common, case in which temperature, hydrostatic pressure and shearing stress play their parts in varying degrees. It is further shown that although these three independent variables control the transformations which take place in regional metamorphism, they are so inter-related that it is possible to treat the problem much more simply, with temperature as the single variable to be considered. That this must be so to a large extent is clearly indicated in those areas of regional metamorphism in which it is possible to lay down successive zones of metamorphism, the lines separating the zones being both isothermal lines and isodynamic lines. The pioneer in this type of work was George Barrow, who, over forty years ago, mapped successive zones of metamorphism in the South-East Highlands of Scotland, each zone being characterized by a particular index mineral, those he chose being chlorite, biotite, almandite, garnet, staurolite, kyanite and sillimanite. This work is given a prominent place in the treatise under review, in that it illustrates well the principle that metamorphism is to be regarded as a progressive change, taking place in response to a continued rise of temperature, accompanied first by a rise and later by a diminution of shearing stress. But, in addition, the author treats of every possible combination of chemical composition, temperature, hydrostatic pressure and shearing stress that could possibly arise, and concludes with a chapter on "retrograde" metamorphism.

A criticism of the book which might well be offered by some is that it gives little reference to the work of petrologists outside the British Isles. But, as the author says in his preface, "Rather has it been my design to show that this country enjoys peculiar advantages as a field for research, and that British workers have not wholly neglected the opportunities so liberally offered", and anyone who has read the book will fully concur in this opinion.

The book is well got up, and is illustrated with several hundred drawings of rock sections done with the author's usual skill, which add greatly to the value of the work. Written as it is in a style which is above reproach, and containing as it does much of the philosophy of our science, this book, together with the same author's *The Natural History of Igneous Rocks*, might well be taken by students as a model upon which to fashion their own attempts at scientific presentation. As a treatise upon metamorphism it will long remain a standard work to be consulted by geologists; and it is perhaps characteristic of it to say that it will be more appreciated by field workers than by museum specialists. It is a book which worthily maintains the best traditions of British geology, which, ever since the days of Hutton and Lyell, have always been characterized by a certain sanity of outlook in approaching problems of this nature.

W. D. W.

Correspondence.

The Alimentary Glands of the Earthworm, *Eutyphœus*.

DR. G. S. THAPAR's note on the alimentary glands of the earthworm *Eutyphœus* published recently in *Current Science* [1] contains observations and ideas originally made and put forward by me and communicated already to the Indian Science Congress[2] and the U. P. Academy of Sciences.[3] In appropriating these results of mine, Dr. Thapar has made mistakes, which would not have occurred, had he confined himself to his own observations. For instance, in the last para of his note, he states: "The blood-supply of the glands is *from* the dorsal vessel and *from* the subneural vessel." As a matter of fact, a subneural vessel simply does not exist in *Eutyphœus*, much less supply blood to any structure. Further, even the dorsal vessel does not supply blood to the glands; it really collects blood from them. In the earlier part of the note, a statement is made that "the glands are separated from each other by intervening septa" (page 129). The fact is that instead of being separated as stated by Dr. Thapar, all the five pairs of glands form one continuous structure. This fact was noticed by Beddard[4] as early as 1889 and I have verified it. It cannot escape observation, if one were to examine the sections under the microscope even with a little care.

In my paper on this subject read before the Zoology Section of the Indian Science Congress at Allahabad (1930), I with Mr. M. B. Lal reported that the glands opened into the gut by several small or large openings all along their length, to which Dr. Thapar makes no reference in his note, in which he has recorded a similar observation. Further, I have recorded two experiments of mine on these glands to prove that they have a digestive (peptic) function. In a paper which I read at the Lucknow Meeting of the U. P. Academy of Sciences (Dec. 1931), I put forward the two ideas that the nature of the blood-supply of these glands suggested a hepatic portal system and that the function of the glands indicated that of a liver or hepato-pancreas. In support of these ideas, I adduced relevant evidence. It is difficult to believe that Dr. Thapar, working in the same Department and at the same place, was unaware of these conclusions of mine when he wrote (p. 130) that "the branches of both the vessels (dorsal and subneural) ramify in the substance of the glands and form a complete anastomosis, thereby indicating a kind of portal system. Further investigation may show that the glands are of the nature of a liver that pours a digestive secretion into the gut."

It is obvious that a portal system cannot be formed out of vessels, one of which, at any rate, is non-existent. Dr. Thapar has, of course, not seen the large *ventral-intestinal vessel* which exists in the worm and really supplies blood to the glands, and not the dorsal and subneural vessels as he has wrongly assumed. The ventral intestinal runs along the ventral wall of the gut for the last 107 to 127 segments of the worm. I applied the term "liver" to these glands after I had made sure of their correct blood-supply and ascertained their digestive function and again after I had obtain d preparations showing glycogen granules, within the cells by staining them with Best's carmine, knowing full well that the more important function of the liver is to store absorbed food. It is necessary to draw Dr. Thapar's attention to the fact that a mere imaginary portal system such as he has ascribed to the glands with no further proof or evidence of their hepatic character cannot make a "liver" of them in the sense understood even by an elementary student of Zoology.

K. N. BAHL.

Dept. of Zoology,
Lucknow University,
December 15, 1932.

[1] *Curr. Sc.*, **1**, 128, 1932.
[2] *Proc. Ind. Sc. Congress*, Allahabad, 248, 1930.
[3] *U. P. Acad. Sc.*, Dec. 21, 1931.
[4] *Q.J.M.S.*, **29**, 114, 1889.

With reference to the above note of Dr K. N. Bahl, I wish to mention the following points :—

1. Colonel J. Stephenson,[5] then Principal and Professor of Zoology at the Government College, Lahore, suggested the problem to me in a letter dated the 19th August 1918 (still in my possession) and as a result of my investigations during the years 1918—1922, I read a paper on the "Alimentary glands of earthworms of the genus *Eutyphœus*" at the Tenth Indian Science Congress in 1923, when Dr. Bahl was himself present, and in participating in the discussions supported my results. This he was able to do because he had access to all my preparations and dissections. In further discussions, one of the members raised the question of the functions of these glands, which were regarded as digestive, something of the nature of a liver.

2. Dr. K. N. Bahl has himself included the abstract of the paper in his quinquennial report of the department published by the University of Lucknow in 1928 (page 112) and has accepted the priority of my work.

3. The work was left unpublished, as soon after I proceeded to England for advanced studies, where the entire manuscripts with the accompanying diagrams were seen by some friends, who are now in the Universities in India. Having taken up an entirely different line of work in England, and also due to pressure of work since my return, I did not have time to publish the results of my work earlier.

4. The work on the Physiology of the glands, now claimed by Dr. Bahl as his own was actually carried out as late as 1929 by one of our former students, now colleague in the department.

Now to the mistakes pointed out, I would reaffirm my conclusions by saying that :—

[5] Then you might investigate "The peculiar diverticula which you will probably find on the intestine about the middle of the body; are they always in the same segments, or is the position variable? What is their histology, and does it differ from the intestine in general?....Note also any particular features in the blood supply." Extract from a letter from Col. J. Stephenson, dated 19th August 1918.

1. The glands are not five pairs as mentioned by Dr. Bahl, but there are four to five *double*-paired bodies, as can be seen by unaided eyes even in ordinary dissection.

2. The point raised by him that the septa do not divide the glands is also misleading. The septa are clearly present, as can be seen from the accompanying figure, extending between the glands of each segment, at any rate in the two species investigated by me.

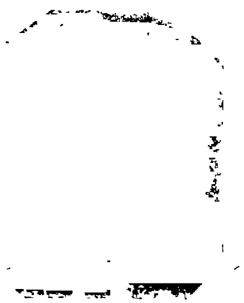

Fig. 1.

Longitudinal (vertical) section of E. waltoni passing through the glands, showing the extension of septa. s. septum.

3. Each pair of bilobed glands communicate with the intestine below by *two* pairs of apertures, one for each lobe, and not by "several small or large openings all along their length" as stated by Dr. Bahl. If he intends to see these structures clearly, he should employ *double embedding Celloidin* method when he would be able to cut complete series of sections along with the intestine and body wall and come to the same conclusions.

4. As regards the blood-supply, I am sorry for certain typographical errors [1] in my original note, but I find that Dr. Bahl has committed a serious mistake. On further investigation he will realize that it is not the *ventral intestinal vessel* as stated and traced by him from segments 107-27, but it is the *supra-neural* (*ventral*) *vessel* that supplies the glands. This supra-neural vessel, on reaching segment 84, sends a pair of branches

[1] Errors in the original note:—read "supra-neural" for "sub-neural," and read in the references "Oxford, The Clarendon Press" for "Oxford University Press".

Fig. 2.

Glands seen from the ventral side, showing the distribution of the ventral blood-supply from the supra-neural vessel. Intestine is cut to show clearly the lateral loops (1).

that run laterally below the glands, one on either side and supplies blood by giving a branch to the glands in each segment (Fig. 2). This would still maintain the existence of a kind of portal system mentioned in my original note.

These facts will speak for themselves. It is needless to say that my note was a brief summary of the main facts dealt with in my longer paper, which was first sent to the Editor, *Current Science*, but from the nature of the work the entire manuscript could not be published. My critic probably thought that it was the last word I could write on the subject, but before he could discuss the morphological errors in my paper, he should have made conclusive observations himself and not have based his conclusions on meagre facts.

In fact I would not enter into controversy with Dr. Bahl, who claims to be "original author" of these glands, but I would certainly protest against his appropriation of the work of his colleagues and assistants. Dr. Bahl could have waited for the publication of my paper, which is now in press, when some further facts in the structure of these glands would also be known.

In conclusion, I am much indebted to the Editor for the courtesy shown in referring the counternote to me for a reply before its publication.

G. S. THAPAR.

Department of Zoology,
The University of Lucknow,
January 24, 1933.

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CONTENTS.

Science and the Pace of Life.

IN an interview with a press correspondent at Bremen before he went on board the liner, 'Oakland', for San Francisco, Professor Albert Einstein is reported to have said that the present pace of life was too fast for the man-in-the-street even to catch the newspaper headlines and it was imperative that we slowed down. "A few years ago people had a chance to sit down and think. It could not be helped if some did not make use of the opportunity, but now no one is in a position to stop and think even if he desires to do so. We are moving too fast to allow a general understanding of science. The public is not much interested in it nor does it understand science. It is paradoxical, but apparently true, that the very instruments of science, instead of being devoted to help common men to a greater understanding of reality are doing just the opposite and are only succeeding in befuddling things even more. Scientific technique is growing so fast that it must soon slow down to permit the ordinary man to catch up."[1]

To a casual reader of these sentences, if they have been reported correctly, they might seem to contain a severe indictment of the attitude of scientists towards the general public, and might even be understood to convey the impression that Professor Einstein thought that the progress of scientific investigations would not lose much if they were suspended for such time at least as would enable the common people to assimilate their great advances. It is perfectly true that the rush of modern life in Europe and America is far too tumultuous and excited to permit the man-in-the-street to stop and think of what is going on around him but science may not be the only contributory cause of this senseless impetuosity. We seem to forget that 'the world has not and never had any assured hope of progress and perfectibility' and neither acts of Parliament nor achievements of scientists can coerce them. The restlessness and discontent of the present age have their roots in social and economic causes and it is doubtful if the progress of science assisted in their acceleration. Most men are the victims of half-knowledge which is worse than honest ignorance, and being products of a bad system of education, are unable "to turn the light of knowledge on

their own hearts while doing their own work." The present age has ceased to regard leisure and tranquillity as indispensable for adorning human environment and has placed implicit faith in wealth as the chief necessity for the embellishment of life.

This change in the scale of human values must account for the feverish pleasures and restless frivolities connoted by the "pace of life" to which Professor Einstein refers. Human happiness is conceived as centering in material comforts and the doctrine which assigns a subordinate position to worldly goods has become infructuous. The suggestion that greed is misery and its absence, happiness will have no meaning to the age which worships the golden calf. The thriftless yearning for money accounts for the mad rush of life and the unequal distribution of wealth, for much of the world's wickedness. There have been great civilizations in the past history of the world in which the ostentatious display of wealth formed the most conspicuous feature of the national pomp and pageantry, but history does not record that the people were consumed by such sinister passions as disfigure modern civilization. If in the days of the Mauryan dynasty and under Gupta administration unlocked doors did not excite the cupidity of the people, a great atavistic change must have since come over the human mind, a certain section of which laughs at locks, safes and science. Under the influence of growing industrialism, the concentration of population in urban areas, the stress of economic competition and the general prevalence of squalor, crime and poverty, the human mind has been insidiously estranged from spirituality which has been for ages its sheet anchor. The principal defect of modern civilization is the total absence of the fear of the Lord whose place is taken by Scotland Yard and the magistrate. The criminal, therefore, embarks on his private enterprise fairly convinced that he can elude human eyes and all other forms of anti-social practices are traceable to the same cause.

The invention of rapidly moving vehicles has brought the continents nearer each other, promoted commerce, stirred the instincts to accumulate large wealth and has also spread disease and has enabled international gangsters to set up *alibis*. The quieter and more normal aspects of life have nearly ceased to interest us and the growing tendency for the sensational and the abnormal is reflected in our public tastes, amusements, fashions and literature. This morbid craving for stupefying thrills which is becoming general, is symptomatic of the degenerative process of the human mind which has missed the essence of absolute life, its hopes, its beauties and its ideals. The conflict between religion and science which occupied the greater part of the nineteenth century, has been wrongly assumed to have proved that the ideals of the former are thrown into the unknown future, thus paving the way for the purely materialistic conception of life. The attempt to interpret the world in mechanical and quantitative terms has led to the application of these principles to human life which was conceived to be an automaton and which, escaping from the stern discipline imposed by religious ideals, seeks its pleasures limited rather by the power of its enjoyment than by the apprehension of their effects on its intellectual, moral and spiritual endowment. The reason for the human mind's breaking away from religious doctrine is partly due to its non-recognition of man as an organic factor of the world and no theory which separates the two can satisfy philosophy and science. We are reaping the fruits of the supposed senseless antagonism between science and religion and its manifestations must necessarily perplex thinking minds. Instead of being mutually antagonistic, they represent the two modes of approach to the same problem, *viz.*, life, in the investigation of which both are handicapped by the limitations of human intelligence and the defectiveness of the instruments of study. We are more conscious of our life than all the facts and evidences against 'life' as a spiritual entity and this very imminence of 'conscious life' baffles a detailed conception of its essence. The limitations of science are not different from those of the human mind and their continuance must indicate that the intuitive perceptions on which religion bases its doctrines of right and wrong, are quite as safe a guide as any that can be wished for. The promptings of the heart are far more true than the ratiocinations of the head.

The pace of life is not set by science alone though its discoveries on the practical side may have given it an impetus. Science is occupied with the investigations of the properties of matter, their causal relations and their behaviour under certain induced and normal conditions but its office does not cease with the discoveries which it

makes. It has a higher purpose and nobler destiny. Most of these discoveries have a practical application which may be directed to the improvement of life as well as its destruction, but science does not lead the way to either. The prostitution of the gifts of science is the business of the commercial and industrial syndicates and of the Government. It is here where the scientific results are applied to the practical problems of life that the pace commences, stimulated largely by economic competition, trade jealousy, fat dividends and capitalization of industry. The hunting after money like every species of hunt, is intoxicating and in its mad pursuit, the graces and beauties of life are ruthlessly sacrificed for those goods which all religions condemn as the parents of every vice and wickedness. The gold frenzy is at its critical point just now and when it subsides religion and science will have to step in to increase the wealth of the world by substituting new values in regard to human happiness which is at present treated as synonymous with material comfort. It is when we have reintroduced fear and admiration in our town life which is marred by social unrest, when we have humanised the commercial and industrial organizations which are riddled by maladjustments, when the rural population is enlightened enough to become intelligent participators in the gifts of learning and in civic administration that hopes may be entertained of the co-ordinated progress of the nation, with sufficient leisure and tranquillity to devote time and talents to the enrichment of their home and environment.

No one can be more vividly conscious of the limitations of science than he who has lived it, and its function is "no more to save our bodies than it is to save our souls". It seeks to uncover the veil of nature and deals with her facts and pheno mena disclosing new worlds of thought, reality, laws and history of the visible universe. With the more technical parts of science, the general public can have very little to do, but it ought to be possible for those who have attained a reasonably high degree of education to become acquainted with the general advances of those departments of knowledge in which they are most interested or in which they have received their earlier training. To democratise science need not necessarily involve its degradation. At present the whole firmament of public life is dark, illumined here and there by a few stars of the first magnitude whose glory is scarcely discernible in the immense general gloom of the sky. What Professor Einstein wishes is a widespread diffusion of light throughout this vast area, each body in it having the power of self-luminescence. It would be too narrow a view to take that the task of science begins and ends with research; for if the knowledge of science is good then it must be good for something and for somebody. It is perfectly legitimate for the scientist to emerge from the laboratory and give the people who care, an account of the joys and pleasures and the difficulties and trials in the prosecution of his studies and make them feel the same thrills, and participate in the cultural benefits which may have accrued to the investigator himself. All the agencies that are impressed in this task, *viz.*, the Universities, the learned societies, the scientific associations and congresses and the press, have established wide channels of communicating knowledge to the general public, but their efforts are obscured by causes over which science has little control. We have to cure the gold fever before science can come to its own.

In India the task is far harder. Education has scarcely touched the outer fringe of the vast population. Those who have received the benefits of education are interested in matters and problems far removed from science. The younger generation is concerned more with the task of obtaining a livelihood than with extra courses of studies for the cultivation of mind. Those that have worldly goods, leisure and a fair measure of tranquillity are engrossed with activities naturally befitting their station in life. To the businessmen science is a superfluity. The Indian universities are nevertheless engaged in overcoming the inertia and in improving the pace of life in the right direction; but it will certainly take a long time for an exotic knowledge conveyed best in the foreign language to permeate and enlighten the whole of the Indian population. Whether it be in India or in any country, public life when freed from the tyranny of gold will instinctively seek knowledge, create leisure for the enjoyment of the beauties of art and literature, acquire power to visualise the higher ideals and the ambitions of a larger life than the one circumscribed by the narrow limits of industries, commerce and lop-sided progress.

Hyperfine Structure of Elements in Mercury Arc—I.

NUCLEAR MOMENT OF ZINC 67.

By Prof. B. Venkatesachar, M.A., F.Inst.P., and L. Sibaiya, B.Sc., A.Inst.P.

THE mass-spectrograph analysis of the isotopic constitution of zinc by Aston (*P.R.S.*, **130**, 302, 1931) has revealed the existence of seven isotopes with relative abundance as given below:

Mass Number	64	65	66	67	68	69	70
Percentage abundance	48.0	2.5	25.9	5.3	17.1	0.85	0.38

Recently, Bainbridge (*Phys. Rev.*, **39**, 848, 1932) has shown that the ions of mass numbers 65 and 69 measured by Aston were hydrides of Zn 64 and Zn 68. Bainbridge's densitometer curve of the mass-spectrogram seems to indicate that the percentage abundance of Zn 67 is considerably greater than Aston's estimate. It can, however, be safely assumed that this odd isotope has an abundance not exceeding 10%. If as in the case of cadmium the odd isotopes give rise to the satellites, in zinc they must be expected to be far less intense relative to the main lines than in cadmium or mercury, where the relative abundance of the odd isotopes is 23% and 30% respectively. The small percentage of the odd isotope 67 along with its comparatively low atomic weight renders the satellites of zinc lines faint and fuzzy. The failure of the early observers to obtain hyperfine structure in zinc lines is to be traced to this cause. Schüler and Brück (*Z.P.*, **56**, 291, 1929) finding the lines simple concluded that the result was due to the absence of odd isotopes, Zn 67 being then unknown. Snoek and Bouma (*Z.P.*, **38**, 368, 1926), Wali Mohammed (*P.M.*, p. 1112, 1928) and McLennan and Allin (*P.M.*, **8**, 515, 1929) had even earlier found the lines to be single. More recently Schüler and Keyston (*Z.P.*, **68**, 174, 1931) and Murakawa (*Z.P.*, **72**, 793, 1931) have independently come to the conclusion that the nuclei of all the isotopes of zinc have zero moment based on the fact that the lines show no structure. Hence in this re-examination of the zinc lines it was thought necessary to devise an experimental arrangement in which the satellites are relatively enhanced without introducing complications arising from self-reversal.

The source used is a long column mercury arc, more than 30 cms. long, with a current density of about 1.5 amperes per sq. cm., through which a slow stream of zinc vapour is continuously passed. The apparatus in Fig. 1 is made of Pyrex glass with a detachable fused quartz window W at one end for observation. When the necessary vacuum is reached, the main arc between the mercury cathode K and the tungsten anode B is started, and a few minutes later the long column arc between K and A lights up. The main arc is then switched off. The zinc in the side tube Z is then gradually heated electrically and a stream of zinc vapour is passed through the long arc. The axial radiation is first analysed by a Hilger E_1 spectrograph with a glass train and each line of the zinc triplet $4^3P_{012}—5^3S_1$ is separately examined by three Lummer plates, all of them definitely known to give ghost-free patterns. Assuming that the ratio $\frac{\text{emission}}{\text{absorption}}$ is the same for all the components of a line, it follows that in a long column the weak satellites, suffering little absorption relative to the main line, are enhanced. An examination of the photographs of the triplet patterns reveals indubitably the existence of hyperfine structure in zinc, but because of the faintness and diffuse character of the satellites the following values require further confirmation:—

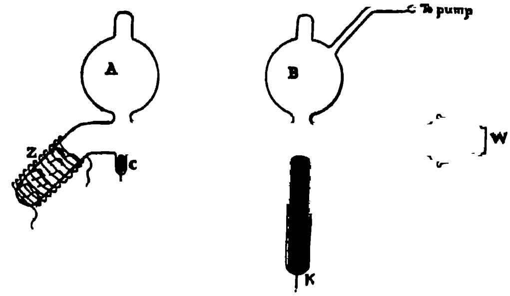


Fig. 1.
Diagram of Source.

Line		Structure $\Delta\nu$ in cm.$^{-1}$ (Int.)
4810	$4^3P_2-5^3S_1$	$+0\cdot319$ (1[illegible])
		$+0\cdot147$ (2[illegible])
		$0\cdot000$ (10)
		$-0\cdot177$ ($1\frac{1}{2}$)
		$-0\cdot315$ (0)

Line		Structure $\Delta\nu$ in cm.$^{-1}$ (Int.)
4722	$4^3P_1-5^3S_1$	$+0 \cdot 312$ (1)
		$+0 \cdot 131$ (2)
		$0 \cdot 000$ (10)
		$-0 \cdot 153$ ($\frac{3}{4}$)
		$-0 \cdot 288$ (0)
		$-0 \cdot 365$ ($\frac{3}{4}$)
4680	$4^3P_0-5^3S_1$	$+0 \cdot 271$ (0)
		$+0 \cdot 087$ (1)
		$0 \cdot 000$ (10)
		$-0 \cdot 155$ (1)
		$-0 \cdot 409$ ($\frac{1}{2}$)

Figure 2 gives the densitometer curve of Zn I 4680 Å $4^3P_0-5^3S_1$ kindly taken by

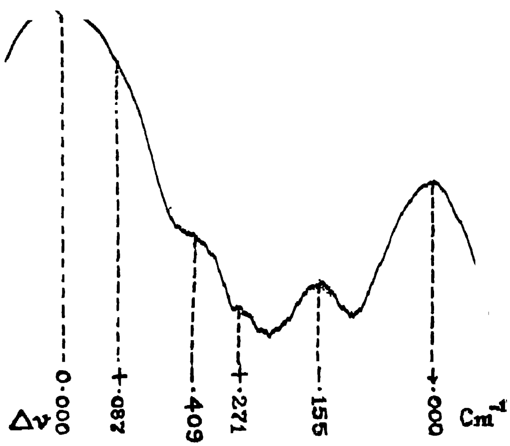


Fig. 2.

Microphotogram of the Lummer plate pattern of the Zn I 4680 Å.

Messrs. Carl Zeiss and shows clearly all the satellites of this line. The observed structures for these lines indicate that the nuclear spin moment of the zinc isotope Zn 67 is most probably $\frac{1}{2}\frac{h}{2\pi}$ and the hyperfine levels are all regular and not inverted as in the case of cadmium. Based on these assumptions a tentative scheme of levels proposed is indicated in Fig. 3. This accounts for most of the observed satellites, only a few relatively fainter ones remaining unexplained. The main lines as in the case of cadmium have to be ascribed to the even isotopes of zinc. The observed hyperfine structure cannot be the result of the shift due to the several even isotopes, as the relative intensities of the components bear no resemblance to the relative abundance of the even isotopes.

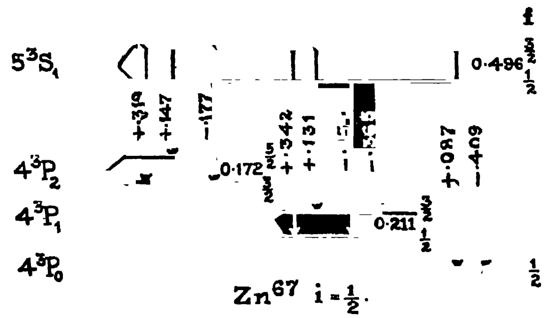


Fig. 3.

The fact that other investigators have almost invariably reported the absence of structure in the prominent arc lines of zinc raises the question whether in the present case, the large admixture of mercury vapour has not any influence in bringing up the satellites. We raise this question because in the case of cadmium under similar conditions of excitation we have observed additional satellites which do not work into the Schüler scheme. The same is the case with the line 5351 Å of Tl I. It must, however, be admitted that one has to establish beyond doubt that the presence of a foreign substance such as mercury is a necessary condition for the appearance of these additional satellites. There is always the possibility that these faint satellites may be caused by isotopes present in such small relative abundance that the mass-spectrograph has not been able to reveal them. Or on the other hand if the conditions of excitation, the presence of a foreign vapour and other factors influence the structure so far as the faint satellites are concerned, we shall have to trace their occurrence to a cause hitherto not considered. For on the hypothesis of a nuclear spin alone, it becomes increasingly difficult to understand why a change in the conditions of excitation should bring out new satellites. The insufficiency of the present theory to account for the hyperfine structure phenomenon in all its aspects has, however, been pointed out by other investigators.

The Problem of the Lantana.

By A. V. Varadaraja Iyengar, M.A., M.Sc., A.I.C., A.I.I.Sc.,

Department of Biochemistry, Indian Institute of Science, Bangalore.

IT seems almost incredible that a small ornamental hedge shrub introduced into India about a century ago should have developed into pest proportions and overrun millions of acres of cultivable land and forest areas in almost every province of this country! Yet such is indeed the case: the menace of the lantana is one of the most serious problems of India to-day and unless a quick and cheap method of controlling its spread is soon discovered, the rapid invasion of this naturalized exotic will do incalculable harm to the preservation and progress of agriculture and forestry in the country.

Lantana Camara Linn. (*Syn. L. aculeata* Linn) belongs to the natural order, *Verbenaceae* and would appear to have been originally introduced into this country from Mexico. It is a thorny shrub with re-curved prickles on the stems and branches, leaves possessing a strong and pleasant odour and flowers varying in colour from yellow to crimson. The fruits, which are formed in large numbers practically all round the year, resemble black drupes and are readily consumed by birds and animals, which disseminate the seeds through their droppings. Under favourable conditions the shrub forms a dense, impenetrable growth often reaching a height of over ten feet, the thorny branches forming a network resulting in a closed canopy. The plant flourishes under varying soil and climatic conditions, in regions of high and low rainfall (200—30 inches per annum), in rich as well as poor soil and in low-lying regions as well as on hill slopes upto a height of about 4,500 ft. above sea-level. Its growth is most intense among the uncultivated lands and scrub-type jungles of the Deccan plateau, parts of the Vindhyas, Chota Nagpur and Assam, while in the deltaic regions, particularly those on the East Coast, it is either sparsely distributed or does not occur at all.

The lantana is, normally, a light-loving plant but it can also grow under moderate shade. It withstands drought, is highly tenacious of life and regenerates quickly after being cut, trampled or burnt by fire. The plant burns readily even in the green thus facilitating the spread of forest fires and consequent destruction of more valuable species. After the fire the lantana is th first to recover; it comes up with a dens growth than ever before and thus smothe out other species that may regenerate mo tardily. It propagates readily from stum or cuttings but in the field or jungle th regeneration is generally from seeds.

During recent years the spread of lanta has been enormous and rapid. About years ago, the shrub was found in isolat patches in uncultivated and fallow lan but now it has spread throughout India a Burma, particularly in the Deccan platea where it encroaches even on cultivated lan with the result that its eradication has no become one of the most important a immediate problems of the farmer. U fortunately no systematic record of th spread of lantana in different parts of th country is available but the following da relating to four forest ranges in North Sale Madras Presidency, would illustrate th position:—

Range	Area under lantana in acres 1917	1931	Spread during t interv
Dharmapuri	Nil	20,844	20,84
Anchetti	45	37,524	37,47
Denkanikota West	1,472	45,806	44,33
Denkanikota East	2,005	35,090	33,08

In the district under reference the ar under lantana has increased from abo 3 to 42 per cent of the total forest lan within a short period of fourteen yea Judging from the present rate it is n improbable that almost the entire area not only North Salem but also the remaini part of the Deccan plateau will soon overrun by this highly aggressive shrub.

Further instances of the dangers arisi from the spread of lantana are not wantin Culturable wastes and fallow lands are re dered unworkable: the soil is depleted of i nutrition and subsequent crops almost i variably fail. The erstwhile grazing groun are now covered up with lantana whic in addition to suppressing the growth grass, also prevents the cattle and sheep fro gaining access to the little that may enclosed within. In the deciduous type forests lantana is chiefly responsible f periodical outbursts of forest fire while in th semi-evergreens it is steadily ousting th

more valuable species, causing degeneration from the original climax type. Lantana is a bad host for sandal because it fails the latter in seasons of drought and subjects it to excessive shade in others. Judging from the high incidence of sandal spike in lantana areas, the shrub would appear to be, in some way, connected with the spread of that dreaded disease. In many parts of the country lantana is found to harbour injurious insects including malarial mosquitoes so that it becomes a source of danger to other plant life and a menace to public health.

The existence of lantana is not, however, an unmixed evil: it has also got some valuable properties which have either not been fully understood or adequately utilized. In addition to making an ornamental hedge plant, its ability to thrive on some of the poorest soils like gravel or hard laterite facilitates the opening up of areas which are inhospitable to most other plant species and which would otherwise become rocky and barren. The plant itself contains several valuable ingredients, some of which are being utilized while the others are still awaiting proper application. The leaves and flowers contain essential oils which were studied by Kanga (*Jour. Indian Inst. Sci.*, **1**, 93, 1914-18) and later by Moudgil and his co-workers (*Perf. and Ess. Oil Rec.*, **13**, 173, 1922; *ibid.*, **16**, 9, 1925). The oils are yellow in colour with pleasant and somewhat powerful odour: they are being distilled by some firms but their uses would still appear to be obscure. Edel Behram investigated the possibility of using the leaves as substitutes for tea. He detected the presence of a large number of enzymes including a powerful oxidase corresponding to that present in tea. He fermented the leaves and obtained a product which though resembling tea in appearance did not yield a beverage of the same quality (*Jour. Indian Inst. Sci.*, **2**, 195, 1918-20). The above study was essentially a preliminary one and requires repetition under standard factory conditions. De, Ganesh Rao and others have shown that the composition of different parts of the lantana plant, particularly the leaves, would point to their being suitable for the manufacture of synthetic organic manures (*Agri. Jour. India*, **25**, 143, 1930): the more recent observations of Subrahmanyan and Jagannatha Rao show that composts prepared out of lantana contain a fairly high percentage of phosphoric acid, a constituent which is sadly wanting in most Indian soils (*Jour. Indian Inst. Sci.*, **15A**, 89, 1932). The possibility of using the twigs for the generation of heat and power, the manufacture of mineral fertilizers from the residual ash, the products of destructive distillation of the whole or different parts, the application of the residual charcoal for adsorptive or clarifying operations in arts and manufacture, the disinfective and insecticidal properties of the oils and related preparations, the uses of the variegated pigments present in abundance in the flowers—these and related problems are still awaiting solution.

Although the aggressive and pestilential nature of lantana would provide a strong argument for its eradication, yet the few good qualities which it is known to possess and the inadequacy of our knowledge regarding the others would justify its retention provided it does not endanger the life of other valuable plant species in the forest or on the field. The problem would, therefore, resolve itself into one of controlling the distribution and spread of lantana.

In recent years, several attempts have been made, particularly in South India, to check the spread of lantana but, unfortunately, without much success. The problem engaged the attention of the Coorg Government as early as 1912. Tireman drew pertinent attention to the evil effects of lantana on other forest species, particularly sandal, and proposed an elaborate scheme for its elimination from that province. His method consisted in stumping the plants in February or March and removing the cut material away from the stumps and burning it. The stumps were to be subsequently pulled out in the rainy season when the ground is soft. Frequent uprootal in the above-mentioned manner for at least four years were considered necessary to ensure the success of this mechanical operation (*Indian Forester*, **42**, 385, 1916). Tireman's scheme involved the clearing up of 63,000 acres in the course of 12 years at a total cost of 4½ lakhs of rupees, but unfortunately it was not adopted. A special legislation known as "The Coorg Noxious Weeds Regulation" was introduced in 1914, but no action seems to have been taken to prevent the natural spread of lantana.

Insect control of lantana is claimed to have been successful in the Hawaii islands where the agromyzid fly feeds on the immature seeds and thus prevents the

regeneration of the plant. With a view to determining whether similar methods of biological control would be possible in India, the Government deputed Rao Bahadur Y. Ramachandra Rao in 1916 to study the insect relations of lantana and to suggest means of checking its spread. The results of the investigations are embodied in a long and useful report (*Dept. Agri. India, Memoirs Ent. Series*, **5**, No. 6, 1920) wherein the author has listed the various species of insects visiting lantana. No evidence could, however, be found to suggest that any of the indigenous species is capable of keeping the shrub sufficiently under check. The author suggested, therefore, that the foreign fly should be imported into India. The proposal did not, however, meet with general approval: in the preface to the Memoir under reference, Mr. Bainbridge Fletcher, the Imperial Entomologist, viewed with apprehension the possibility of the agromyzid fly proving a menace to the other members of the order *Verbenaceae* and, in particular, to teak (*Tectona grandis*) in which case the loss will be irreparable. Some attempts were still made to introduce the agromyzid fly into India. Dr. Kunhi Kannan obtained a few insects with great difficulty and released them in Bangalore: but though he was satisfied that the insects did no harm to teak, he could not yet get them to 'catch' on lantana with the result that they all escaped and could not be subsequently traced, despite careful search! (*Agri. J. India*, **19**, 504, 1924.) Even in Hawaii the agromyzid fly has no very marked effect on lantana: the area under that shrub has always remained small so that it is difficult to define the possible efficacy of introducing the insect into India on a large scale. The insect would not appear to be as specific in its action on lantana as is the cochineal insect on prickly pear so that the possibility of effectively controlling the spread of lantana by the introduction of that seed fly would appear to be rather remote.

Cultural control of lantana is a promising line of enquiry, but no systematic attempt in this direction has so far been made. There is evidence to show that certain soil conditions as also the floristic make up of certain regions are highly effective in checking the spread of lantana. Even in areas like North Salem where lantana abounds there are numerous little patches where the shrub either makes poor growth or does not appear at all. In certain localities where the soil contains a high percentage of kaolin or certain other light, silicious earths, lantana is generally absent while other species flourish. It has already been stated that lantana does not thrive under dense cover and that heavy foliaged species of the high forest type generally keep out the incursion of this shrub. As an instance of this it may be mentioned that in the Siddapuram R.F., in North Salem, lantana does not grow under the heavy shade of the evergreen shola species and even in places where it has gained entrance the shrub invariably exhibits a weak growth. It is true that the introduction of *Ficus elastica* or castor did not prevent the spread of lantana in certain parts of Madras, but further systematic study might reveal the presence of more powerful species that would not only check the spread of lantana but would also help to eliminate it from other areas.

The use of chemicals for the eradication of undesirable plants is well known and is extensively adopted in America. There are a number of cheap inorganic and organic chemicals which are deadly in their action on all forms of plant-life: there are others which are selective or specific in their action. It is not improbable that a judicious application of one or both of the above types of compounds would be helpful in either keeping down lantana or eliminating it altogether. To be efficacious, the chemical must be easy of application and possess high penetrative power reaching the farthermost ends of the plant; it must be highly toxic even at low concentrations and effective irrespective of season. A thorough knowledge of the physiology of the plant is also essential to gain an insight into the nature of its response to various treatments. An investigation into the above and related aspects of the problem has been undertaken by the author in co-operation with the Madras Forest Department. Various observations of interest have already been made both in the laboratory and on the field among which particular mention may be made of the fact that chlorates and arsenicals are highly effective in killing lantana. A study of the various methods of application is also under way.

Much more yet remains to be done. The extent of spread of lantana in different provinces, the rate and manner of its progress, its effect on other forms of vegetation and its relation to plant pests and carriers of human disease require investigation

in detail. The precise nature of the soil conditions that check the spread of lantana has yet to be ascertained. A systematic survey of the ecology of that shrub has to be made in different parts of the country, particular attention being paid to areas where other forms of vegetations have steadily dominated over lantana, so that the observations with regard to the flora as well as the fauna of such localities may provide the necessary clues to similar control in other places as well. The introduction of the foreign fly does not appear to be a promising line of attack, but in view of the incomplete evidence provided by the previous work, some further trials may be carried out with that insect. In the laboratory a great deal of systematic work is still awaiting to be investigated. Some useful beginnings have no doubt been made at the Indian Institute of Science, but more intensive work has still to be carried out, particularly with regard to the conversion of the different parts of the shrub into synthetic organic manure for use in areas where other forms of vegetation are scarce. Attention should also be paid to the econ mic combustion of the plant for generatic of energy, the utilization of the differe products of distillation in arts an manufacture, and the exploitation of tl ferments, oils and other constituents alread known to be present in the plant. Tl observations on chemical control have to b repeated in various provinces and in differe seasons and the conditions standardized f extended adoption of the technique. Tl above and related problems are of con siderable practical importance and it earnestly hoped that they will soon engag the attention of the Imperial Council Agricultural Research, the Forest Depar ments of the different provinces and tl scientific laboratories in different parts the country.

The author desires to express his thanks t Dr. V. Subrahmanyan for many helpf suggestions, and to Messrs. A. M. C. Littl wood and S. Rangaswamy for co-oper tion in the research and much valuab information in connection with the occu rence and spread of lantana.

Obituary.

Lt.-Col. John Stephenson, I.M.S., C.I.E., F.R.S.

THE sad news of the sudden death of Lt-Col. John Stephenson, C.I.E., M.B., Ch.B., F.R.C.S., D.Sc., F.R.S., F.R.S.E., I.M.S. (retd.), on 2nd February 1933, came as a great shock to his old pupils and friends throughout India.

Colonel Stephenson was born in 1871 at Padiham, Lancashire, and was educated at the Burnley Grammar School and the University of Manchester. In Manchester he had a very distinguished career in zoology and medicine. After qualifying as a doctor Stephenson acted for a time as the House Surgeon in the Manchester Royal Infirmary and the London Hospital for the diseases of the chest till in 1895 he passed the competitive examination for the Indian Medical Service. For the first five years of his service in India he was on military duty and saw active service with the North-West Frontier Expedition of 1897. He was posted as a medical officer on plague duty in the Punjab in 1900, and up to 1906 served as a Civil Surgeon in Rawalpindi, Gujrat, Ambala and other places. Early in 1906 he went on leave and passed the Fellowship examination of the Royal College of Surgeons, London, with a view to appointment as Professor of Surgery in the Lahore Medical College. Fortunately for the study of zoology in India, the recent experiment of the transfer of the teaching of pure science subjects, like botany and zoology, from the Medical College to the Government College, Lahore, had not, for want of properly qualified teachers, proved the success that its initiators had hoped. The then Lieutenant-Governor of the Punjab, Sir Denzil Ibbetson, who was a personal friend of Colonel Stephenson, knew that Stephenson had studied zoology in Manchester under the famous professor A. Milnes Marshall, and knowing Stephenson's capacity as an organiser and worker, he prevailed on him to undertake the duties of the recently created professorship of biology in the Governmen College, Lahore. He held this position ti 1912 when, in addition to being the Professo of zoology, he was appointed Princip of the Government College, Lahore. H retired from service in India in Septemb 1921, and went over to Edinburgh where l was appointed Lecturer in zoology in the Un versity. In November 1929 he left Edinburg for London and till shortly before his deat he used to carry on zoological research in the British Museum of Natural Histo as an unofficial worke

On his appointment Professor of biology 1906 Stephenson, wl had been out of tou with zoology for near eleven years, start earnestly to brush up h knowledge of the subje and bring it up-to-dat Though he had a fair good teaching museum his disposal there w neither a properly equi ped laboratory nor a library worth the nan in the Government C lege, Lahore. He w however, able to g together before long first-rate teaching m seum, a very good wor ing library and by 19 had succeeded in havi a new biological laboratory built for t institution in which he was working. a result of his labours, zoological instru tion in Lahore attained a very high standa in a few years and he was able to fou a very productive school of zoology in t Government College. Several studer from his laboratory, in whom he instill the faculty of critical work and care investigation from the very beginning, a now holding influential zoological po tions throughout the country, and it w solely due to his initiative and inter that a really flourishing school of zoologi research was established in Lahore. H tenure of office was marked by conspicuo success as a teacher, while his administrati qualities were responsible for making t institution under his charge into a real

first-rate place of instruction. He also took a very active interest in the affairs of the Punjab University and in addition to being the Dean of the Faculty of Science, he acted during the last year of his stay in India as the Vice-Chancellor of the Punjab University.

Stephenson was not content with teaching zoology only, but started research work in zoology soon after his appointment in Lahore and by 1909 had produced a thesis which earned for him the degree of Doctor of Science of the London University. His researches from the very beginning were concentrated on the Oligochætes, and from 1907 onwards till shortly before his death he published numerous papers on Oligochætes of India and other areas. The results of his systematic work on Indian Oligochætes for over 16 years were collated in his volume on the Oligochætes in the "Fauna of British India" series and since that date he was recognized as one of the two chief authorities on this group of worms. In 1929 he completed the masterly morphological and systematic monograph on the Oligochætes which was published in 1930 by the Clarendon Press, Oxford. In addition to the systematic studies on the Oligochætes he carried out researches of outstanding character on the intestinal respiration of Oligochætes and worms in general, and published several very important morphological papers on the structure of these worms in the "Transactions of the Royal Society of Edinburgh" and the "Proceedings of the Royal Society of London". His monograph on the Oligochætes clearly indicates his extensive knowledge of the structure and classification of the Oligochætes and a very thorough acquaintance with the literature on the subject. In addition he dealt in detail with such important questions as convergence, the polyphyletic origin of the various genera and families and the geographical distribution of earthworms. In connection with the distribution of these worms he discussed in detail the former existence of an Antarctic continent and land-bridges between India and Australia on the one hand and the Peninsular India and Africa on the other. He also published a very valuable account of the Nemertines of the River Clyde in the "Transactions of the Royal Society of Edinburgh".

Stephenson was a great linguist and all his spare time was devoted to the study of early Persian authors. He published a collated edition of all the known manuscripts of *Hadiqat-ul-Haqiqat* in the "Bibliothica Indica" published by the Asiatic Society of Bengal together with an English translation and annotations of the *Muzhat-ul-Qulub* in the publications of the Royal Asiatic Society of London.

For his work as an administrator and teacher Colonel Stephenson was awarded the title of C.I.E. in June 1919. His contributions to the advancement of knowledge were recognized by the award in 1920 of the Keith Memorial Medal of the Royal Society of Edinburgh and of the Barklay Memorial Medal of the Asiatic Society of Bengal in 1925. He was Fellow of the Royal Society of Edinburgh, and the Asiatic Society of Bengal, and received the blue ribbon of science on his election as a Fellow of the Royal Society of London in 1930. He was appointed Editor of the "Fauna of British India" series in May 1928 in succession to the late Sir Arthur Shipley and since 1931 he worked as the Zoological Secretary of the Linnean Society of London.

Colonel Stephenson was a very brilliant teacher and those who had the privilege of attending his lectures will never forget the care and pains he took in making the subject of lectures really instructive and interesting to his students. He was a sincere and loyal friend and all his friends will miss him for his sound judgment and ever-ready help in all matters relating to education and more particularly to the advancement of zoology in India and later in Great Britain. His extensive circle of friends feel his untimely death as a personal bereavement and extend their sincere and heart-felt condolence to Mrs. Stephenson in her irreparable loss.

B. P.

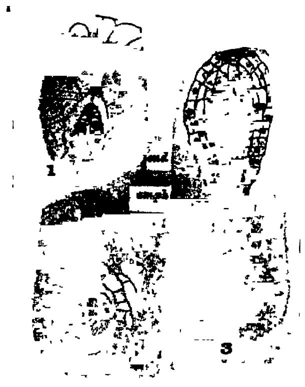
Letters to the Editor.

The Origin of the Archesporium in *Notothylas levieri* Schiff. MS.

VARIOUS authors have proposed to separate the Anthocerotales from the liverworts and place them in a class co-ordinate with the Hepaticæ. One of the main arguments advanced in support of this view has been that while in all the other liverworts the archesporium arises from the endothecium, in the Anthocerotales it comes from the amphithecium.

My examination of *N. levieri*, a common Himalayan liverwort, shows that this distinction can no longer be maintained and favours the retention of the Anthocerotales within the Hepaticæ.

The early stages in the embryogeny of *N. levieri* conform to the usual anthocerotalean type (Figs. 1, 2), but a radical difference is seen in the origin of the archesporium. Unlike the condition observed in the other anthocerotales, the archesporium here originates from the entire endothecium (end.), while the amphithecium (amph.) forms only the wall (Fig. 3).



1 and 2. × Ca 720.
3. × Ca 500.

My conclusion based on the observations of the early as well as the older stages of development of the sporogonium differs from that of Kashyap and Dutt[1] on the same species, which is based on the study of development from the meristematic zone at the base of the capsule and which is to the effect that the archesporium arises from t endothecium as well as the inner layer the amphithecium though they do not gi any figures.

A very careful study has been made me to decide this point and an examinati of numerous preparations which conta embryos at practically all the critical stag of development leaves no doubt that in t species the endothecium (end.) alone fertile (Fig. 3).

As Kashyap and Dutt have already stat there is no columella in *N. levieri*. *N. flabellata*, a species which also lacks columella, the late Prof. Goebel obser that the archesporium arises from t endothecium, but whether the inner cells the amphithecium are fertile or not he co not definitely ascertain.[2] He remarks t these cells like the endothecial cells rich in the protoplasmic contents.[3] In young sporogonia of *N. levieri*, also, sor times similar amphithecial cells are se but a comparison with the older embr shows that these cells never produce archesporium. This fact suggests that *levieri* has been derived by reduction fro species in which the amphithecium fertile. The columellate species of *Notothy* would thus seem to be primitive, wl those without it are reduced.

Several authors (Lang[4], Kashyap[5] a Bartlett[6]) have already emphasized t *Notothylas* shows signs of reduction in species studied by them. In *N. indica* a *N. levieri*, too, as I have shown elsewhe although the capsules usually rem enclosed within the involucre they genera open along one suture as in *Anthoce Hallii.*[6]

S. K. PANDE

Department of Botany,
University of Lucknow,
December 27, 1932.

[1] S. R. Kashyap, and N. L. Dutt, "Two Indian Species of the Genus *Notothylas*," *Proc. Lahore Phil. Soc.*, Sec. IV, 1925.

[2] In a recent paper (*Journ. Ind. Bot. Soc.*, **11**, 1932) I wrongly stated that according to P Goebel the whole of the amphithecium gives to the wall.

[3] K. Goebel, *Organographie der Pflanzen*, Zwe Teil, 1915–18.

[4] W. H. Lang, *Ann. Bot.*, **21**, 201-10, 1907.

[5] S. R. Kashyap, *Liverworts of the West Himalayas and the Punjab Plain*, Part I, 1929.

[6] E. M. Bartlett, *Ann. Bot.*, **42**, 1928.

[7] Pande, *Journ. Ind. Bot. Soc.*, **11**, 1932.

An Interesting Case of Maternal Care in an Aquatic Cockroach, *Phlebonotus pallens* Serv. (Epilamprinæ).

INSTANCES of maternal care are rarely met with outside the order Hymenoptera. It is, therefore, of great interest to record an example from among the cockroaches.

Shelford in his book entitled "A Naturalist in Borneo" mentioned that in the two viviparous species of cockroaches, namely, *Pseudophoraspis nebulosa* and *Phlebonotus pallens*, the newly hatched nymphs swarm on to the body of the mother and cling there.

On the 12th June 1929, I collected a female specimen of *Phlebonotus pallens* near the edge of the water channel of a small stream about six miles from Yercaud (4,500 ft.), Shevroy hills, South India. At the time of collection the specimen showed no extraordinary features and was preserved in spirit along with other aquatic fauna collected from the locality. Recently when the collected material was being sorted by my assistant, Mr. S. Rebiero, it was noticed that this cockroach had about one dozen young ones under its wings, while some were lying loose in the tube. The young ones were very securely packed under and could easily be seen through the wing covers which were now almost clear. A photograph of the specimen with some nymphs *in situ* is given in the figure.

The wing covers of the specimen were carefully displaced to ascertain if and how the nymphs were clinging to the body of the mother. All the nymphs were noticed to be quite free from the body of the mother. This also indicates that they most probably do not at this stage take any food from the mother, as is the case in some other insects. The nymphs are yellow or pale brown in colour and have patches of minute stiff dark hairs on several regions of the body.

The female cockroach does not look at all bulky nor was it awkward in its movements when it was carrying the young ones. The wing covers are large and arched and together with the upper side of the abdomen which is depressed from a chamber inside which the nymphs can be carried about comfortably.

In view of the fact that cockroaches have numerous enemies, the habit of carrying the young ones in the fashion described above appears to be a very efficient safeguard for the protection of the progeny. In life, the wing covers are opaque and the young ones lying under them are so nicely packed that the human eye cannot easily detect on superficial examination that the individual is carrying so many young ones on its body. Moreover, as will be readily understood, this habit, in addition to securing the safety of the nymphs against the attacks of enemies, is very useful for dispersing the species.

I am very thankful to Dr. R. Hanitsch of Oxford, who kindly named the cockroach for me.

HEM SINGH PRUTHI.

Zoological Survey of India,
Indian Museum, Calcutta.
February 2, 1933.

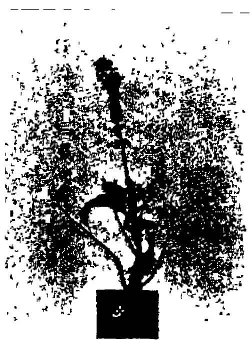
An Unusual Growth Phenomenon in *Coleus barbatus* Benth.

THE Labiate member *Coleus barbatus* Benth. is quite common at high elevations up to 8,000 feet, chiefly in the sub-tropical Himalayas and is rather a hardly herbaceous plant. It grows in rocky situations and its root is tuberous which, according to Cooke,[1] is pickled and eaten by the natives.

In October 1931 (at Naini Tal) while changing pressed plants after a fortnight to fresh drying sheets, certain tiny buds were found jutting out from the region a little above (about 25 mm.) the broken end of the stem of *Coleus barbatus*. The production of buds on dry specimen, specially under such an abnormal condition as that of the plant press, aroused some interest and a close observation was, therefore, made on the very same specimen under similar conditions for a period of about four months.

[1] *The Flora of the Presidency of Bombay*, 2, Part II, 1906.

As a result it was found that the buds continued to grow under the herbarium-sheet and by the end of sixteen weeks each of them had attained a length of about 10 mm. They were, however, vegetative in character. On dissecting one of them out, small leaves were found arranged in the manner as in the ordinary vegetative buds. Owing to their being shaded from light under the herbarium-sheet, the buds had not developed the characteristic green coloration (see photograph). Nevertheless, when exposed to light, they turned green.



Coleus barbatus : The herbarium specimen showing lax central inflorescence and the white vegetative buds (in the black square). × 1/10.

At the same time, it might be mentioned here that the central inflorescence, at the outset, was compact with open flowers. But during the four months that the observations were continued, it was found that the inflorescence-axis also kept on elongating, thus making the whole inflorescence lax (see photograph). The increase in length measured 26 mm. There was, however, no such change observed in the lateral younger inflorescences in which the flower buds had not opened at all.

This peculiar behaviour of *Coleus barbatus* is really interesting as it demonstrates the enormous power of endurance of the plant even under the most unfavourable conditions of the plant press with great pressure and lack of water and light.

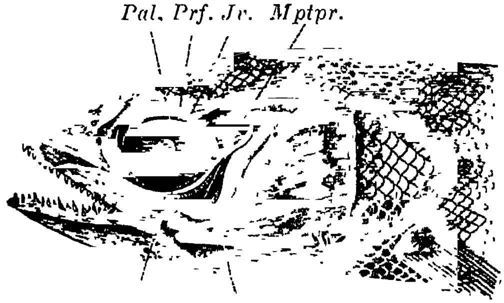
T. C. N. SINGH.

Department of Botany,
Ravenshaw College,
Cuttack.

The "Metapterygoid Process" in the Skull of *Ophiocephalus striatus*.

ONE of the few interesting cranial features of *Ophiocephalus striatus* is the presence of a flat, prominent metapterygoid process. The palatoquadrate bar articulates with the cranium not only by the palatine in front and through the hyomandibular behind, but also by the metapterygoid process, immediately behind the orbit and in front of the Trigeminofacialis chamber. The upper edge of the process is incompletely ossified. A careful study of this structure in other animals clearly shows that the metapterygoid process is homologous with the "Processus ascendens" of Dipnoi and Tetrapoda. The topographical relations of this process

Pal. Prf. Jv. Mptpr.



Mx. Md.

Dissection of the head of *Ophiocephalus striatus* to show the "metapterygoid process" and its relationship with the neighbouring blood vessels and nerves.

Jv.—Jugular vein. *Mx.*—Maxillary branch of the V nerve. *Md.*—Mandibular branch of the V nerve. *Mptpr.*—Metapterygoid process. *Pal.*—Palatine branch of the VII nerve. *Prf.*—Profundus branch of the V nerve.

and the processus ascendens with the nerves and blood vessels are identical. The profundus branch of the V nerve and the jugular vein (*vena capitis lateralis*) pass on the inner side of the metapterygoid process, while the maxillary and the mandibular branches of the Trigeminal pass on its outer side. This feature of the pterygoquadrate bar has not been so far described among any of the Teleostomi.[1] A complete comparative account of the skulls of various members of the family *Ophiocephalidæ* and *Cyprinidæ* (chiefly *Labeo*, *Catla*, *Cirrhina*, etc.) will be shortly published elsewhere.

B. S. BHIMACHAR.

Department of Zoology,
Bangalore,
January 28, 1933.

[1] E. S. Goodrich, *Studies on the Structure and Development of Vertebrates*, p. 413, London, 1930.

Total Efficiencies of Soft X-Ray Excitation and Secondary Electron Emission from Metal Faces.

A LARGE amount of experimental work[1] has been done on the emission of secondary electrons from metal faces due to bombardment by a stream of primary electrons, accelerated by applied potentials less than about 500 volts. However, investigators of this phenomenon have always confined themselves to the measurement of the ratio of the secondary to the primary current as a function of the applied potential and to the observation of critical potentials at which this ratio showed sudden changes. It has recently been shown by me[2] that this ratio for any potential in the case of a given metal is structure sensitive.

Farnsworth[3] has studied the velocity distribution of the secondary electrons by the method of retarding potentials. Since the translational energy of an electron is proportional to the potential to which it is subjected, we can show easily that if f_1 is the fraction in the secondary beam having a velocity V_1, the efficiency of the secondary emission is $f_1 V_1/V$ where V is primary potential. Such efficiencies calculated from Farnsworth's curves for Cu, Fe, Ni and Ag, show generally an initial rise till about 10 volts and then a gradual decrease. This decrease at relatively higher potentials is strikingly similar to the decrease observed in the efficiency of soft X-ray excitation by Richardson and Robertson[4]. Similar experiments by me on polycrystalline and 100 faces of Ni show that the efficiencies are equal in both cases though the ratios of the secondary to the primary current are different at any potential.

This similarity in the secondary electron emission and soft X-ray excitation gains significance from the experimental investigations of Rudberg[5], who finds a large number of slow electrons (having less than 10 volts energy) in both the cases. This fact helps us to account for the observed saturation tendencies in the soft X-ray total intensity curves obtained by Richardson and Robertson[6] and Nakaya[7]. It is obvious that the absorption of the low velocity photoelectrons becomes rapidly more important as the depth of penetration of the soft X-rays is increased by increasing its hardness.[8] Assuming with Richardson and Chalklin[9] that the number of photoelectrons n_0 produced in the medium of the photoelectric plate by the soft X-radiation at an applied potential V, is proportional to this potential and that the depth of penetration is proportional to the average energy of the soft X-ray quantum, we obtain for n the number of photoelectrons leaving the target the expression

$$n_0 \epsilon^{-\beta V} \text{ or } \alpha V \epsilon^{-\beta V}$$

Nakaya's results agree very satisfactorily with this expression.

Full details of this letter will appear in two papers, one in the *Proceedings of the Royal Society* and the other in the *Journal of the Annamalai University*.

S. RAMACHANDRA RAO.

Annamalai University,
Annamalainagar,
February 14, 1933.

[1] For details and previous work, see S. R. Rao, *Proc. Roy. Soc.*, **A 128**, 41, 1930.

[2] S. R. Rao, *Proc. Roy. Soc.*, **A 128**, 57, 1930.

[3] H. E. Farnsworth, *Phys. Rev.*, **31**, 405, 1928.

[4] O. W. Richardson and F. S. Robertson, *Proc. Roy. Soc.*, **A 115**, 280, 1927.

[5] E. Rudberg, *K. Sv. Vet. Handl.*, **7**, 1, 1929: *Proc. Roy. Soc.*, **A 127**, 111, 1930.

[6] O. W. Richardson and F. S. Robertson, *Proc. Roy. Soc.*, **A 124**, 188, 1929.

[7] U. Nakaya, *Proc. Roy. Soc.*, **A 124**, 616, 1929.

[8] S. R. Rao, *Phy. Rev.*, **41**, 374, 1932.

[9] Richardson and Chalklin, *Proc. Roy. Soc.*, **A 110**, 273, 1926.

Engystomatid Tadpoles.

THE usual diagnosis for distinguishing the tadpoles of the families Ranidæ, Bufinidæ and Engystomatidæ[10, 11] is that those of the two former possess rows of larval teeth and horny jaws and those of the latter possess none. In fact the provisional dental characteristics and the shape, size and colour of the jaws of the tadpoles have been used for identifying the adult anura.[12] In examining recently sections of the larvæ of *Caropus systoma* I noticed that teeth do occur, though there is a total absence of the teeth in the tadpoles of *Microhyla* and *Kaloula*. I understand that the teeth which are used for taxonomic

[10] N. Annandale and C. R. Narayana Rao, *Rec. Ind. Mus.*, **15**, Part I, No. 3, 1918.

[11] N. Annandale, *Memoirs As. Soc. Bengal*, **6**, 118, 1917.

[12] C. R. Narayana Rao, *Rec. Ind. Mus.*, **15**, Part I, No. 4, 1918.

purposes will not be a safe guide in the case of Engystomatidæ, in which the character, shape and position of the spiracle, the tail fin, the caudal flagellum and relative proportions of the body are more generally relied upon for diagnosis. The question arises whether the horny teeth of the tadpoles of *Cacopus systoma* represent an arrested stage of development or whether they are vestigial remnants in the process of disappearance. The latter seems the more probable view.

Transverse section of a 20 mm. tadpole of *Cacopus systoma* showing three rows of larval teeth.

If the tadpoles of Cacopus are examined under the microscope it is easy to detect a horny rim investing the free margin of the lips and the teeth occur in various stages of growth, forming minute irregular rows which sections of the oral cavity reveal. All the Engystomatid tadpoles occur almost as a rule on the surface of the tanks and rain

Longitudinal section of the intestine showing the contents.

puddles away from the water margins and are exclusively surface feeders. On the other hand, those of the Ranid and Bufonid families frequent water margins where there is a dense vegetation. Observations made on their feeding habits both in nature and in the laboratory tanks show that the tadpoles of these two families rasp the succulent vegetation, pieces of meat and do not hesitate to develop cannibalistic propensities. Sections of the intestines of the tadpoles of Engystomatidæ show the occurrence of a large variety of micro-organisms, like diatoms, protozoa, rotifera and copepoda. They have never been noticed to nibble vegetation or meat and are easily victimised by the stronger and more predaceous Ranid tadpoles. This habit of passively imbibing the micro-organisms must account for the rapid disappearance of the provisional teeth which in *Cacopus systoma* are therefore vestigial and in the process of disappearance. In the tadpoles of *Microhyla* and *Kaloula*, they have completely disappeared.

I reproduce above the microphotographs of the sections of the intestine of the tadpole and of the buccal region of *Cacopus systoma.*

A. NARAYANA RAO.

Department of Zoology,
Central College, Bangalore,
February 20, 1933.

Amphiboles in the Bababudan Iron Ores.

IN accounting for the origin of the banded iron ore rocks of the Bababudan area, it has been suggested[1] that they are derived from the decomposition of original schists rich in highly ferruginous amphiboles like cummingtonite and bababudanite—which are sometimes seen in the ferruginous quartzites. An obvious difficulty in accepting this explanation has been to account for what has happened to the large amount of magnesia (Bababudanite—12·11% ; Cummingtonite—18·68%)[2] which must necessarily have been found associated with the iron, constituting the original amphiboles.

In the course of a recent detailed examination of several sections of the Bababudan range, a remarkable fact has been noticed that the occurrence of these minerals, *viz.*, cummingtonite and bababudanite, in the iron ore rocks, is confined to narrow zones

[1] W. F. Smeeth, "Notes on a Variety of Riebeckite (Bababudanite) and on Cummingtonite from the Mysore State," *Rec. Mys. Geol. Dept.*, **9**, pp. 86, 87.

P. Sampat Iyengar, "Report on the Geology of Parts of Hassan and Kadur Districts," *ibid.*, p. 73.

[2] W. F. Smeeth, *op. cit.*, pp. 90, 91.

always at the contact of the intrusive trap rocks of the area. This, together with the fact that these amphiboles occur as acicular and lath-shaped crystals—as a rule fresh and glistening—and that when their present distribution in the rock is carefully examined, these acicular crystals are seen running right across the bands in the original rock, seems definitely to suggest that they may be only later minerals developed at the intrusive contacts of the traps with the iron ore rocks and have, therefore, little or nothing to do with the origin of the latter.

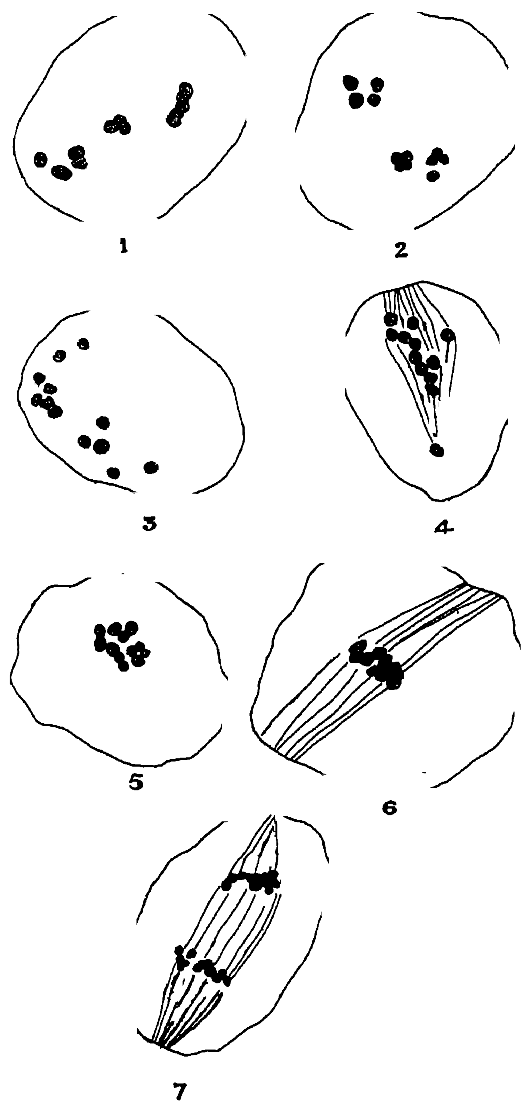
The probable mode of origin of the iron ore rocks is receiving our attention and a detailed account of the nature of the bandings in the hematite quartzites together with the chemical and optical characters of the contact minerals will be published elsewhere.

CHARLES S. PICHAMUTHU.
M. R. SRINIVASA RAO.
Department of Geology,
Central College, Bangalore,
January 30, 1933.

Haploid Plant in Rice (*Oryza sativa*).

HAPLOIDY among seed plants is of very rare occurrence, and the stray cases recorded in a few genera have arisen in hybridization where, due to failure of fertilization, the embryo under stimulus has developed with one set of haploid chromosomes only. There have been only two recorded instances of this phenomenon in cereals. Gaines and Aase (1926) observed among the F_1s of an intergeneric cross (*Triticum compactum* × *Aegilops cylindrica*), a haploid wheat and described its sporogenesis. Recently Morinaga and Fukushima (1931) discovered a haploid rice plant, among the F_1 progenies of a cross between a dwarf and a normal variety of rice. They were able to identify its haploid nature only by the examination of its somatic chromosomes in root tips, as the observation was made too late to study the sporogenesis of the plant.

At the Paddy Breeding Station, Coimbatore, the study of polyembryony in rice has been in progress for some time. In one of the pure lines, some seeds, approximately in the proportion of 1: 1000, were seen to give rise to two seedlings. A large number of these twins had been planted out separately and in all the cases except one mentioned below, the twins proved identical. In this exceptional case while one of the twins was normal, the other was found slightly dwarfed, flowering later than the normal, with a poor emergence and smaller spikelets with complete absence of anthesis. Examination of this plant at sporogenesis revealed twelve univalent chromosomes distributed irregularly (Figs. 1 & 3) in the



nuclear area and later assorting at random at the two poles with the absence of the usual metaphase stages. Only a few cases of this random distribution of chromosomes are figured (Figs. 2 & 4). This irregular distribution of univalents and their random assortment at the poles is in marked

contrast to the normal heterotypic division in the normal plant where the metaphase and the anaphase stages are characteristically regular (Figs. 5 to 7). The peculiar behaviour of this plant at sporogenesis is similar to that reported of haploids in other plants. It is suggested that this haploid might probably have arisen from one of the cells of the female gametophyte. Detailed cytology of this plant is under investigation and will form the subject of a separate article.

Reference to Figures.

(Drawn with the aid of a Camera Lucida at stage level × 1500).

Figures	1	to 4	..	Haploid.
Figures	5	to 7	..	Diploid.

Reference to Literature.

Gaines and Aase (1926), *Amer. Jour. Bot.*, **13**, 373-385.

Morinaga and Fukushima (1931), *Jap. Jour. Bot.*, **6**, Abs. p. 13.

K. RAMIAH.
N. PARTHASARATHI.
S. RAMANUJAM.

Agricultural Research Institute,
Lawley Road P. O.,
Coimbatore,
February 24, 1933.

Helminth Parasites from Certain Fresh-Water Fishes of India.

DURING the course of our investigation on the life-history, economic importance and bionomics of the fresh-water fishes of the Nizam's Dominions, we came across the following parasites in several species of the fishes obtained from the local rivers, *viz.*,

(*a*) *Philometra* sp. (♀), one half of which was pink and the other half whitish in colour, was obtained from a siluroid fish, *Wallago attu*.

(*b*) *Eustrongylides larvæ*, usually purple in colour, were obtained from *Ophiocephalus striatus*, *O. marulius* and *O. punctatus*, *Gobius giuris* and *Mastacembelus armatus*.

(*c*) Specimens of *Isoparorchis hypselobagri* (Billet) were obtained from all the species of fishes mentioned in (*a*) and (*b*) and in addition, from *Ophiocephalus gachua* and *Callichrous malabaricus*. The worms are especially very abundant in the gas-bladder of *Wallago attu*.

(*d*) One form possibly *spirurid larva* (?) has been obtained from *Saccobranchus fossilis*. In this fish another interesting form of parasitic worm has also been discovered which will be described later on.

(*e*) *Contracæcum larvæ* have also been obtained from *Ophiocephalus punctatus*.

It is interesting to note that these parasitic worms are of very wide distribution amongst the fresh-water fishes of India,—most of the Siluroids and Ophiocephalids are predaceous in their habits and either their cannibalistic instincts or their habit of one species preying upon another species that accounts for such a wide prevalence of worms amongst the piscine fauna. It is likely that the adult forms of most of these worms will be ultimately found in fish-eating birds, or some aquatic animals, *e.g.*, predatory fishes, certain reptiles, mammals, etc., the infection may even extend to man as well. Their mode of "anchoring" presents some interesting variations in different species of fishes: some are attached to the mesentery, either lying free, or in an encysted condition, while others bore their way through the muscles of body-wall, and there they may be quite free, or form cysts which appear blackish, not unlike masses of disorganized blood-clots and in certain cases they may even perforate the outer skin of the fish. Further work covering a wider field of the fish-fauna of this State is going on at present in this laboratory, and our results will be published elsewhere. We are aware of certain cestode and tremetode parasites already described by others, infesting a few fresh-water fishes of India.

Here we wish to express our great indebtedness to Dr. H. A. Baylis of the British Museum and Mr. G. D. Bhalerao, Helminthologist, Imperial Institute of Veterinary Research, Muktesar (U. P.) for the correct identification of the worms mentioned above.

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M. RAHIMULLAH.

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Osmania University,
Hyderabad (Deccan).

The Industrial Outlook.

[NOTES ON THE ELECTRIC RAILWAYS IN BOMBAY AND MADRAS.]

By Dr. Ram Prasad.

THE steam locomotive, although highly improved in recent years, has got its own limitations as regards efficiency, tractive effort and speed. The application of electricity for traction has proved its superiority over the steam drive in the above respects and the railways all over the world are electrifying their railroads utilizing either economical hydro-electric power or steam electric power from large central stations. Not only the suburban lines near big cities, but also the main lines radiating from centres of trade, commerce and industry have greatly benefitted by the conversion into electric drive. In Switzerland where there are no coal fields, almost the entire railway system has been electrified as the country is rich in water power. In recent years the railways in India have been carefully considering the change into electric drive and the schemes carried out by the G.I.P., B.B. & C.I., and the S.I. Railways, have proved the superiority of the electrified systems to such an extent that other railways will follow suit in due course.

The heavy suburban traffic of Bombay, a city of nearly 1¼ million inhabitants, and the important long distance passenger and goods traffic especially over the Ghat sections, where the elevation suddenly rises up to 2000 ft. above sea level with gradients of 1 in 37, constitute conditions that are very favourable for electric drive especially as power was available from hydro-electric power stations nearby. The B.B. & C.I. Railways have electrified their suburban section between Bombay and Borivli (30 miles) and the G.I.P. Railway have electrified not only their suburban sections between Bombay and Kalyan (30 miles) but also their main lines from Kalyan to Poona on the South-East and to Igatpuri on the North-East.

The South Indian Railway have electrified their suburban section from Madras Beach to Tambaram (18½ miles) and are also contemplating main line schemes to be taken up in the near future.

The suburban schemes of the G.I.P. and B.B. & C.I. Railways are both on the broad gauge and are similar in design and equipment of sub-stations including rotary converters, etc. The suburban scheme of the S.I. Railway is on the metre gauge and their sub-stations are equipped with mercury arc rectifiers instead of rotary converters. The main line scheme of the G.I.P. Railway is an extension of their suburban system, but the traction is carried on by suitable passenger and goods locomotives, the latter equipped with regenerative braking for service over the Western Ghats between Kalyan and Poona and Igatpuri.

The following is an abstract of the technical features of the G.I.P. Railway:—

1. Capital Expenditure—	
Suburban Scheme	Rs. 2·74 crores
Main line Scheme	Rs. 6·50 ,,
2. Route mileage of track electrified	181 miles
Length of single track electrified including sidings ..	571 ,,
3. Number of Suburban motor coaches	53
Number of Passenger locomotives	24
Number of Freight locomotives	41
4. Aggregate HP of Passenger locomotives	51,990
Aggregate HP of Freight locomotives	1,06,600
5. Number of sub-stations ..	15
Aggregate capacity of sub-station plant	1,00,000 Kw.
6. Steam Power Plant and equipment	4 alternations of 10,000 Kw. each. 6 Boilers of 60,000 lb. steam per hour each.
7. Length of 100,000 volts Transmission line	272 miles.

The suburban system of the G.I.P. Railway was electrified by 1925 and the main lines by 1929. The traction is of the 1,500 volt D.C. system, power being derived through rotary converters in the various sub-stations. Four of the sub-stations receive their power from the Tata Hydro-Electric Companies, at 22,000 volts from the Tata stations at Dharavi and Kalyan. The other sub-stations which feed the main lines from Kalyan to Poona and Igatpuri are fed from the G.I.P. Railway steam electric plant situated near Kalyan, through extra high tension lines at 95,000 volts which run mostly parallel to the railway lines. The wisdom of having installed a steam power plant, when there was sufficient hydro-electric power available

nearby has been questioned. The railway authorities seem to justify the steam plant and say that at the time of negotiations with the Tata Companies, conditions being adverse, there were doubts if they could guarantee priority of supply in the event of shortage of water following a bad monsoon and consequently continuity of service was not certain. In any case if conditions have improved since, it would be economical to draw more power from the Tata Companies and conserve their coal for places where the electrification has not been extended, especially as the railway power plant is so designed as to inter-link with the Tata network.

The steam power plant is designed for pulverised coal and is equipped with 6 boilers each of 60,000 lbs. per hr. steam output and 4 turbo alternators each having an economical and continuous maximum rated output of 10,000 Kw at 6,600 volts with an overload capacity of 20% for 2 hrs. and 65% for 2 minutes. Each generator is connected through an oil circuit breaker to the low tension side of its own 11,000 KVA 95,000 volts step-up transformer and also to the high tension side of its own 1800 KVA unit transformer which feeds the auxiliaries connected with that set. In all the G.I.P. sub-stations the converting plant consists of suitable transformers and rotary converter sets each comprising two 750 volts 1,250 Kw machines in series to give a 1,500 volts D.C. supply. In three of the sub-stations, all switchgear including that for starting, synchronising and connection to the busbar are designed for manual operation, and in others there is automatic operation, *i.e.*, each rotary converter is automatically started, synchronised, and connected to the busbars following the closing of a low voltage control switch. Six of the sub-stations on the main lines are unattended and fitted for supervisory control from the neighbouring attendant sub-stations. All the rotary converter sets and their switchgear are designed for receiving power from the 1,500 volts D.C. line, from the locomotives regenerating as well as for normal operation. A portion of the regenerated energy is absorbed by ascending trains up the ghats and the remainder is converted into alternating current in the sub-stations and delivered to the transmission lines. On the average about 4½% of the input to the rotary converters is returned to the transmission lines. Taking the total input as 6,00,00,000 Kw. hrs. per annum, the energy returned t the high tension lines would be 27,00,000 Kw hrs. per annum. This saving is ample t pay the capital charges on the extra cost (equipping the freight locomotives wit exciters and additional switchgear fo regeneration, a further advantage bein the reduction in brake block renewals.

The locomotives have been designed t meet the exacting conditions of varyin temperatures from 40° F. min. to 130° F. ma and the heavy monsoons near Bombay. Fo the suburban service each train unit consis of one motor coach and three trailers, th normal train during rush hours being mad up of 2 units. Seating capacity of each un is I class 15, II class 42, and III class 38 The motor is of 275 HP and the weight of th four-coach unit is 218 tons, *i.e.*, 5 HP per to of train. The freight locomotives are desig ed with the wheel arrangement comprising (2 sets of 3 coupled axles, so that there is le tendency to skidding of wheels and r chance of breaking of coupling when startin up the 1 in 37 gradients and running awa in down grade. They are equipped with motors each of 650 HP 1,500 volts rath than 6 of 750 volts so that a lower crawlin speed is possible. Further they are equippe with axle driven generators for regenerativ working when the locomotives are haulin trains down the ghats. The complet electrical equipment is easily and conven ently divided into 2 groups so that in th event of any electrical failures one group ca be immediately isolated without affectin the operation of the other thus reducing th possibility of a train being stalled and block ing the road. All the auxiliaries, such a vacuum pumps and compressors, are in dupl cate and a 50 volts battery is installed wit sufficient capacity to give 4 hours suppl for lights and control circuits.

The passenger locomotives for the mai lines were designed to meet the growin demand of traffic with improvement in th timing between Poona and Bombay. The have a tractive effort of 7,500 lbs. at 70 mile per hour and can maintain a speed of 5 miles per hour up a gradient of 1 in 15(These locomotives have to work in combina tion with a freight locomotive while goin up the ghats and should share the load pro perly at the speed desired, that is, of th total tractive effort of 40,000 lbs. required the passenger locomotive should be respons ible for 16,000 lbs. leaving 24,000 lbs. for th freight engine, both running at a speed c

about 30 miles per hour. Similarly, the locomotives have to run in combination under regenerative control down the ghats. The motor equipment of the passenger locomotive consists of six motors of 750 volts with two groups of control apparatus and all safety devices. It is remarkable that 41 freight locomotives and 24 passenger locomotives have efficiently replaced 171 steam locomotives including 96 ghat engines.

The G.I.P. Railway main line electrification scheme is the largest and the most comprehensive in the British Empire, with perhaps the recently electrified Southern Railways between London and Brighton coming next. The combined G.I.P. and B.B. & C.I. suburban electrification schemes have helped Bombay to successfully overcome the housing problem and develop the suburbs till now considered impracticable.

THE SOUTH INDIAN RAILWAY ELECTRIFICATION—MADRAS.

The S.I. Railway have adopted the 1,500 volts D.C. system very similar to the traction system of the Bombay Electric Railways, but the track is of metre gauge and the scheme is of special interest in that it was not merely the conversion of existing steam-operated lines to electrical working, but included the construction of new tracks and stations to accommodate suburban traffic between Madras and Tambaram, that had increased so much as to impede the main line services. Another novel feature is that the 1,500 volts D.C. supply is obtained by means of 1,500 volts 1,500 Kw mercury arc rectifier sets instead of rotary converters used in Bombay. Power is obtained from the steam power plant of the Madras Electric Supply Corporation at 33,000 volts and is supplied to the mercury arc rectifiers through suitable transformers and switching apparatus which are designed for automatic operation. These rectifiers can take 100% short time overloads easily.

The service on this system was opened in April 1931 and has been working quite satisfactorily. The traffic has tremendously increased with better speed and comfort and has electrification scheme. A new double track for the electric trains has been constructed from Madras to Tambaram ($18\frac{1}{2}$ miles) and certain shunting yards near Madras have been electrified so that shunting operations and freight services can be carried out with electric locomotives. There are two rectifier sub-stations, one at Egmore and the other at Meenambakam, with the car sheds located at Tambaram.

There are 17 articulated coach units, each consisting of one motor coach and 2 trailer coaches; 4 locomotives and 2 battery tenders. The articulated motor coach units are arranged for multiple unit working, so that trains may be made up with 3, 6 or 9 coaches according to the traffic requirements. The electrified equipment has been designed to give an average speed of 40 miles per hour with a fully loaded train over the whole distance with station stops at an average interval of $1\frac{1}{2}$ miles. A three-coach unit is carried on 4 bogies and the power equipment consists of 4 motors of 122 HP each, connected permanently in pairs in series, one pair being mounted on each of the two intermediate bogies. The motors are of self-ventilated type, but owing to the excessively dusty conditions the ventilating air is drawn from inside the coach through ducts and sliding flexible joints. Power control is on the all-electric can shaft system similar to that in use on the G.I.P. Railway, and the whole of the control equipment is housed in a compartment at one end of the centre coach, which also contains a 4 Kw 1,500/60 volts motor generator set for supplying the control and lighting circuits, and exhauster driven by a 1,500 volts motor. An emergency battery is also provided, which is charged automatically and floats across the terminals of the motor generator set. Ten of the train units contain I, II, III class and seven contain entirely III class. The weight of a unit is 73 tons. The 4 locomotives are fitted with articulated bogies each equipped with two nose suspended axle-hung motor rated at 160 HP. As in the case of the motor coaches, the ventilating air is drawn from the interior of the vehicle which in turn has air inlets fitted with filters. The superstructure is of the box cab type with the control equipment mounted in a centre compartment, with a driving position at each end. The electrical equipment of the locomotives is generally similar to that of the motor coaches with the exception that it is not arranged for multiple unit operation, and 3 running positions are provided in series and also in parallel by means of weakened field notches. The locomotives are capable of hauling 500 ton freight trains or 250 ton passenger trains at a speed of from 25 to 40 miles per hour. They are 32 ft. long over buffers, $8\frac{1}{2}$ ft. wide with a weight of 42 tons. Braking of the units is by

compressed air, but vacuum brakegear is fitted in addition, to suit the existing rolling stock.

One of the chief difficulties encountered in laying out this electrification scheme was the fact that there were a number of small yards at some distance from the main line which could not conveniently be provided with overhead construction although at the same time it was extremely undesirable to have to provide a steam locomotive whenever movement had to be carried out at these yards.

The problem was solved by providing in addition to the locomotives two battery tenders equipped with heavy duty batteries capable of supplying power to the locomotives at 440 volts. When a locomotive is required for service of the kind indicated one of these tenders is attached to it and after the limit of overhead construction has been reached the pantograph is lowered and by changing over a single switch the locomotive runs on the 440 volts supply from the battery. These tenders which weigh only 21 tons have a capacity of 158 Kw hrs. at the 5 hr. rate of discharge of the battery and they are equipped with a complete charging switchboard and other auxiliaries.

The South Indian Railway have not only built new type of stations to handle the suburban traffic on the electric trains, but have done away with all the level crossings in Madras City which has improved the main roads and relieved the traffic congestion. When the hydro-electric power of Pykara is available for the South Indian Railway, they may take up the electrification of the main lines near Coimbatore, Madura and Trichinopoly and also the mountain railway up the Nilgiris.

The Government of Mysore are also investigating the electrification scheme for the Nanjangud-Mysore-Bangalore system. Electric power is available at every railway station on the line between Nanjangud and Bangalore, in addition to the 35,000 volt sub-stations at Bangalore, Closepet, Chennapatna and Mysore. The scheme as worked out by the South Indian Railway for their metre gauge lines with mercury arc rectifiers seems adaptable with advantage for the Mysore Railways. Unlike Madras and Bombay, Mysore cannot buy cheap seaborne coal, is located far away from Indian coalfields and is compelled to pay very high rates for the coal required for their locomotives. Both the Mysore Railways and Cauvery Hydro-Electric Power schemes are owned by the State which helps a great deal in the economy of the electrification. The approximate cost of electrification may be in the neighbourhood of 18 to 20 lakhs. With a guarantee of power supply from the Cauvery Power Station at Sivasamudram and prospects of saving money going out of Mysore to the extent of the cost of coal purchased from outside the State, the electrification scheme deserves very careful consideration so that the details will be worked out at an early stage and the conversion to electric drive may be taken up with advantage.

The Railways which radiate from Calcutta are also considering suburban electrification as a first step which may later lead to main line electrification. Unlike Bombay, Calcutta is situated very near the largest coalfields in India, and it is possible to generate power economically in large central stations with steam power even though there are no big hydro-electric power stations nearby. The ordinary steam locomotive has to carry its own raw materials, such as coal and water, and use them in a boiler whose efficiency is far below that of large modern pulverised coalfield boilers and drive an engine whose efficiency is much lower than that of the central station steam turbines. The logical procedure is to generate power economically at a suitable steam or hydro-electric power station and distribute the energy to hundreds of locomotives with minimum of loss. The first step in nation-building is the conservation and proper development of the natural resources, and electrification plays a very important part.

Traction on the D.C. system is one phase of development, as there are several railways running on A.C. systems using single phase or three phase supply. The mercury arc rectifier which has just come into the field of D.C. traction has various modifications, which make it useful in converting power from 3 phase A.C. systems to single phase A.C. or *vice versa*. Recent investigations have shown that the mercury arc rectifier will play a very important part in the future electrification schemes as it is capable of heavy overloads and adapts itself easily for automatic operation.

A Bureau of Mycology for India.

IN his Presidential Address to the Botanical Section of the Indian Science Congress last year, Dr. H. Chaudhuri advocated the establishment of a Bureau of Mycology in India and this suggestion is repeated by him on p. 180 of *Current Science* for December, 1932, where it is said that it has been expanded in the *Madras Journal of Agriculture* to include Entomology in a combined Bureau to cover both subjects.

The primary functions of such a Bureau would naturally be (1) to serve as a clearing house for the collection and dissemination of information and (2) to organize a system for the prompt identification of injurious fungi and insects. Subsidiary functions might be (3) to arrange periodical meetings of workers interested in the subject, (4) to facilitate the "circulation" of research workers through knowledge of the work going on at different centres, (5) to facilitate the exchange of material for study, (6) to keep in touch with manufacturers (*e.g.* of apparatus or spraying materials), (7) to provide for visitors good library, herbarium and museum facilities for consultative purposes, and (8) if possible to undertake the systematic revision of groups of organisms of economic importance where such revision is called for.

Experience has shown that the function (1) above is best fulfilled by the publication of abstracts of current literature, the formation of card indexes of past and present literature on specific subjects, and the answering of enquiries by correspondence. The maintenance of a lending library, where possible, is also useful. (2), (3) and (4) require no comment. (5) can best be met not so much from the immediate resources of the Bureau as by being able to make use of sources of supply that may be scattered throughout the world. This applies particularly to cultures and preserved specimens. (6) and (7) require no comment. (8) is necessary at times because it may be impossible to fulfil function (2) adequately without such a revision.

It will be seen that there is no need to duplicate (1) provided that it is adequately carried out somewhere else and the information conveyed in a suitable language. Both in Entomology and Mycology the existing organizations provide fully for all reasonable needs of English-speaking countries. None of the Dominions nor, indeed, any foreign country has found it necessary to set up similar organizations and there is no need for a separate Indian one. (2) is in most countries provided for in national herbaria, museums, and similar institutions, and India possesses the foundations for such (so far as fungi are concerned) in the Agricultural Research Institute at Pusa and the Herbarium of the Royal Botanic Gardens, Calcutta. The reason why the far-flung British Empire has needs transcending these local ones is that only at some one centre (which convenience and local facilities has dictated should, in most cases, be London) can all the scattered threads be gathered together and knowledge gradually gained of the identity of the organisms injurious to plants in many diverse regions of the globe, of their similarities and differences, and of the risks they might present if they became disseminated from one part of the world to another. Only one such centre is obviously required and it must keep in close touch with national centres in India and elsewhere. None of the other functions of a Bureau detailed above appears to require special provision in India, as they are either already sufficiently covered to meet local (as well as inter-imperial) needs or would be too costly to duplicate in any single country. (3), (4), (6) and (7) fall under the first of these considerations, (5) the second. In regard to this last, the collection of type cultures at Baarn in Holland and the Lister Institute in London are sufficient to meet the requirements of most workers with living fungi and the setting up of other collections is to be deprecated as liable to impair their efficiency. All other requirements of material for study from foreign or other outside sources can best be met through the agency of a central organization such as those in London. Function (8) is one that is only incidental to the work of a Bureau, but every research institution wherever situated could usefully engage in this much-needed study.

Unless, therefore, Dr. Chaudhuri has some other type of organization in view than that considered above, there would appear to be no need for separate Indian Bureau. The requirements of India are covered by the central Imperial organizations, which no local one could replace, for the reasons given above, without wholly unnecessary duplication and waste of money. The service of these central organizations is not "a

matter of grace" as Dr. Chaudhuri states. It is a service paid for in hard cash and at a far cheaper rate than could be obtained at any institution carrying on similar work in India, as it is subsidized by all parts of the Empire and each contributing country has only to pay a fraction of the total cost.

Dr. Chaudhuri's light-hearted remark that it takes months or even years to obtain a report on any material sent to the central organizations is sufficiently met by the following figures. In the two years 1930 and 1931 the average time that elapsed between the date on the forwarding letter from India and the date of the report from the Imperial Mycological Institute was 37·45 days, a period that includes the time taken in transit from India, probably for parcels about three weeks. In 1932 the average time was 47·72 days, but this difference is almost wholly accounted for by a single enquiry which took 132 days and involved a great deal of critical work.

E. G. BUTLER,
Director.

Imperial Mycological Institute,
Ferry Lane,
Kew, Surrey, England.
January 16, 1933.

* * *

THE many mycological workers in India will feel heartened by Dr. Butler's declaration that they can expect the service of his organization as a matter of right since "it is a service paid for in hard cash" and not given "as a matter of grace" as put by me through ignorance. We may perhaps now look forward to Indian mycologists being employed in Dr. Butler's Bureau, since India is paying part of the expenses.

I am very pleased to know of the prompt way in which enquiries from India are dealt with. If I complained about the delay in getting reports, it was due to my experience of the Bureau in its early days. The data now supplied by Dr. Butler, leave no doubt about the promptness with which enquiries are now attended to, and I feel certain that the Imperial Mycological Institute will now receive many more enquiries from India than before. Mycologists in India will feel indebted to Dr. Butler for this statement.

Now as regards my plea for the establishment of an Indian Bureau of Mycology, I fully agree with what Dr. Butler has said regarding the functions of a mycologica bureau. Dr. Butler will no doubt grant that the Mycological Section at Pusa has been doing much of the work which he ascribes to such a bureau. If there is any duplication of the work that is being done in London, I maintain it is a necessary duplication, and every country has got to do that kind of work independently. But I would not suggest that the Indian Bureau should start publishing abstracts of mycological literature; that work is very efficiently done by the London Bureau. If, however, I am permitted I may suggest that along with the abstracts, the addresses of the author may as well be printed. That will facilitat exchange of material direct.

My whole endeavour has been to press fo the establishment of a culture bureau in India, similar to that of Baarn, where th cultures of fungi isolated here may b maintained and made available to th workers in India. The situation and climat of Pusa being unsuitable for the purpose, suggested the establishment of a separat mycological bureau. Since the publicatio of my last letter, this matter has bee discussed by the Imperial Council of Agri cultural Research, India, and the ide accepted, and I am glad to state that effort are now being made to find out the bes way to give effect to it. Under the presen financial condition the establishment of separate bureau not being a feasible propo sition, the best thing would be to develo the Mycological Section at Pusa into proper mycological bureau. This involve refrigerating arrangements for maintainin cultures, which however need not prove a insurmountable obstruction as there is an ic plant there which has got an output suffic ent to meet the demand.

Mycological workers in India are indebte to the Mycological Section at Pusa for tl help and facilities given there. If it no develops into a proper mycological burea and I have no doubt it shall do so soo nobody will feel more happy, I am sur than Dr. Butler who has been associate with it from the very beginning. There need and scope for its development, an certainly money spent there will not l money wasted.

H. CHAUDHURI.

Punjab University,
Lahore,
February 14, 1933.

Marriage among the Ūrālis of Travancore.

By L. A. Krishna Iyer, M.A.

THE Ūrālis are a small jungle tribe found in the Peermede and Thodupuzha taluks of Travancore. Their life of isolation on the hills has kept them away from the civilizing influence of the plains with the result that they preserve most of their primitive customs and manners. It is proposed to treat here of their marriage customs.

Marriage is by exchange of sisters. No man can have a wife unless he has a sister whom he can give in exchange. An Ūrāli cannot purchase a wife from her parents by giving the equivalent in property of some kind, whether it be in goods, cattle, or money. A man who has no sister to offer in marriage has often to lead a life of single blessedness. Formerly, an Ūrāli married as many wives as he had sisters. Now a man does not marry more than two women. A number of young men remain unmarried for want of women. The scarcity of women as wives was caused in large measure by the selfish action of old men. The result is unequal distribution of women as wives between males of the community, the old men having more than the young who had to go without any. Cross-cousin marriage is also in vogue. The marriage ceremonial is very simple in form. It takes place both before and after puberty. The boy's uncle settles the marriage. The bridegroom and father go to the bride's hut and escort the bride to their hut, where the bride's party is treated to a feast. Dowry consists of bill hook, clothing and vessels.

Polygamy was widely prevalent formerly. It is now very limited. A man marries more than one woman for assisting him in his agricultural operations or for want of progeny by his first wife.

Polyandry is said to prevail where there is a surplus of men. Rev. Mateer observes that the Ūrālis practised polyandry like the Todas, but it seems to have died out. It is now observed that there are more males than females. In two hamlets there are 65 girls to 100 boys.

The system of marriage by exchange of sisters is found among the Ullādans and Malavēdans of Travancore, the Mādigas of Mysore, the Bhothiyas of United Provinces, the Garos of Assam, the Australians and other backward tribes of the world. It seems probable that this practice was at first a simple case of barter, and that it originated in a low state of savagery, when women had a high economic value as labourers, but when private property was at so rudimentary a stage that a man had no equivalent to give for a wife except another woman. The same economic motive might lead the offspring of such unions who would be cross-cousins, to marry each other, and thus the custom of cross-cousin marriage would arise and be perpetuated.

It is said that the exchange of sisters by their brothers was probably older than the exchange of daughters by their fathers, since relationship between brothers and sisters, children of the same mother, must have been well known and recognition of that relationship conferred on brothers a degree of authority which enabled them to exchange their sisters or their sisters' daughters for other women whom they either married themselves or gave in marriage to their sisters' sons.

The custom of cross-cousin marriage is considered to have arisen from exchange of women by brothers. It seems to have been the direct consequence of interchange of sisters in marriage and that the latter flowed directly from the economic necessity of paying for a wife in kind. Thus exchange of sisters co-exists with cross-cousin marriage not only among Ūrālis, the Ullādans, and the Malavēdans of Travancore, but among other tribes in other parts of the world.

A Bibliography of Zoological Work in India.

By P. W. Gideon,
Department of Biology, Karnatak College, Dharwar.

WITH a view to compiling a bibliography of the work done by zoologists in India, so as to afford a ready reference to all workers on Indian problems, I have asked through the Chairmen of the Boards of Studies in Zoology, Medicine and Agriculture of Indian Universities, all zoologists engaged in research or other work to co-operate by sending me reprints of their work published during the last five years (1928-32), and to give all information regarding the problems on which they are at present engaged.

In reply to this request reprints of publications and information regarding zoological work are coming in, and to avoid unnecessary correspondence I would like to bring to the notice of zoologists the following points:—

1. Care should be taken to mention the year and month of such publications where reprints are not sent.
2. Universities and Institutions as have been approached and are *not* engaged in any zoological work may kindly reply to that effect, as delay may be caused in waiting for their information.
3. Information of *work in preparation* is necessary, as a short review of the various centres of research with the various sections of zoology in which they are engaged, is contemplated.
4. So far the information received from the Chairmen, Boards of Studies in Zoology of a number of Universities, has dealt with the work done by the University Staff only. I should like it to be made clear that in order to compile a complete bibliography it is also necessary to have the work done by members of the Zoology Department in each college affiliated to the University.

I have also asked the various research institutions throughout India to furnish me with the same details, and would like to take this opportunity of asking private institutions and individuals engaged in zoological work to co-operate also. It would be very helpful if the necessary information could be sent in as early as possible as the work is to be completed during the long vacation, March to June 1933.

The following is a list of the Universities and research institutions I have already approached, but not included in this list there may be other institutions and individuals whose help is also solicited for a completion of the scheme.

UNIVERSITIES.—Agra, Aligarh, Allahabad, Andhra, Annamalai, Benares, Bombay, Calcutta, Dacca, Delhi, Lucknow, Madras, Mysore, Nagpur, Osmania, Patna and Punjab.

RESEARCH INSTITUTIONS.—

1. The Zoological Survey of India, Indian Museum, Calcutta.
2. The King's Institute, Guindy.
3. The School of Tropical Medicine, Calcutta.
4. The Department of Fisheries, Madras.
5. The State Research Laboratory, Rajkot.
6. The Government Museum, Madras.
7. The Prince of Wales Museum, Bombay.
8. The Imperial Council of Agricultura Research, New Delhi.
9. The Indian Central Cotton Committee Bombay.
10. The Imperial Institute of Veterinar Research, Muktesar.
11. The Imperial Entomologist, Pusa.
12. The Locust Research Entomologist, Lyallpur.
13. The Indian Lac Research Institute, Ranchi.
14. The Central Research Institute, Kasaul
15. The Fisheries Bureau, Chepauk, Madra
16. The Department of Medical Service Nova Goa.
17. The Department of Medical Service Pondicherry.
18. The Veterinary Serum Institute, Bareilly.
19. The Colleges of Agriculture, Poona an Coimbatore.
20. The Forest Colleges, Dehra Dun an Coimbatore.
21. The Veterinary Colleges, Bombay an Madras.
22. The Medical College, Vizagapatam.

Research Notes.

On the Graptolites prepared by Holm.

OLIVER M. B. BULMAN, (*Arkiv for Zoologi*, Band 24, Hafte 2, 1932) in a series of papers makes a distinct contribution to our knowledge of Graptolites, based on the magnificent collection of 'etched' Graptolites prepared by Holm. The greater part of the material in the Holm collection was obtained from Gra Lituitkalk and the Glauconithaltig, Gra Vaginatumkalk of Oland and the Ordovician limestones. The forms described are referred to their particular stratigraphical formations and the paper is profusely illustrated with beautiful photographs and figures. The descriptions of the different genera are exhaustive and the paper forms an excellent work of reference for all students of Palæontology.

Continuous Cometary Spectrum.

THE continuous cometary spectrum has recently been attributed by Willi M. Cohn (*Astrophys. Jour.*, **76**, 277, 1932) to the bombardment of ions of different materials in the rarified tail of the comet by electrons assumed to be constantly emitted from the sun. Laboratory experiments are given which show that the cometary spectrum is unpolarised according to theory. On the other hand if the scattering is of the Tyndall type a complete polarisation is to be expected which is almost entirely absent in the violet type spectrum of comets. The appearance of CO^+ and N_2^+ bands favours the suggested origin of the spectrum and indicates that the pressure in comets may be of the order of 10^{-4} to 10^{-5} mm. of mercury. Since the electron velocity is reduced by its travel through the turbid medium of cometary matter, the theory explains also why with increasing distance from the head of the comet the maximum is shifted from 4000 to 4700 Å in the tail of the comet Morehouse.

Spraying in Coffee Production.

THE function of spraying in coffee production is the subject of two recent articles by W. W. Mayne in *The Planters' Chronicle* (**28**, 34, 53, 1933). After drawing attention to the fact that the Leaf-Disease is almost specific to coffee, the author adduces evidence to show that treatments like cultivation and manuring, though helpful to plant growth, will also, generally, favour the development of the fungus causing the disease. On the other hand, spraying eliminates the fungus and, by minimising the risk of leaf fall or destruction, it also provides the plant with an increased effective leaf area for the photosynthetic assimilation of carbon dioxide. The plant bears more flowers and fruits than it might have done in the diseased condition and thus gives a bigger yield of seed. The available evidence would also suggest that manuring, though helpful in maintaining soil fertility, does not appreciably increase crop-yields.

The author does not, however, explain how spraying leads to increased crop-production even in areas where the destructive effect of the Leaf-Disease is not perceptible. Furthermore, the effects of the sprayed chemicals both on the physiology of the plant and on the chemical composition and microflora of the soil into which it is ultimately washed down cannot be entirely ignored, particularly in the light of the literature that has been accumulating in recent years. It is known that the more progressive planters are liberal in their sprayings so that the quantities of chemicals thus applied per unit area would be considerable. It is suggested therefore that a systematic investigation directed towards the elucidation of the biochemical significance of spraying not only in the case of coffee but also in those of other plantation and horticultural crops of economic importance should be undertaken.

Kaolin Minerals from Felspar.

IN a recent number of *Journal of Geology* (**40**, No. 8) Messrs. A. E. Badger and Abde Ally have published a short note on their experimental work on the formation of kaolin minerals from felspar. Selected felspars of known composition have been subjected to attack by dilute hydrofluoric acid or carbonic acid under specific conditions of temperature and pressure, and the resulting alteration product studied by X-ray methods. The action of dilute hydrofluoric acid at about 225° C. on a potash felspar resulted in the formation of a kaolin mineral—kaolinite or dickite. The action of carbonic acid on powdered felspar did not result in the formation of any kaolin mineral. The authors consider that this

may have been due to the relatively short duration (156 hours at temperatures up to 60° C.) of these experiments.

Comparative Studies on the Physiology of the Iris.

J. Z. YOUNG (*Proc. Roy. Soc. Lond.*, **B. 112,** 776, Jan. 1933), after a comparative study of the iris muscles of different fishes, has come to certain important conclusions regarding their physiology. In Selachians of which Scyllium, Mustelus and Trygon have been chosen as examples for study, he has found that the sphincter iridis muscle is not under direct nervous control. A quite different result has been obtained in bony fishes like Lophius and Uranoscopus. The varied effects of drugs like adrenaline, acetyl choline, pilocarpine and eserine have been noted on the different muscles of the Iris.

Study of the Upper Ionised Atmosphere in Bengal.

PROF. S. K. MITRA and Rakshit have recently communicated the results of their study of the upper ionised atmosphere in Bengal by wireless echoes of short delay (*Phil. Mag.*, **15,** 20, 1933). The group retardation method as developed by Breit and Tuve has been employed with a transmitter of the type originally suggested by Appleton and Builder. From a knowledge of the time interval between the direct and reflected pulses reaching the receiver, the equivalent height of the upper F-layer has been calculated. The recording system, which is located at a distance of 3·8 km. from the transmitter, consists of a receiver and a cathode ray oscillograph. One pair of the deflecting plates of the latter are connected to the receiver output and the other to the neon tube oscillator for obtaining the linear time base. The height of the F-layer is observed to decrease gradually as the day progresses, the evening value being usually about 20% lower than the midday value. The average height of the F-layer in the afternoon is about 250 km. Multiple echoes become very conspicuous near sunset and their number increases as one moves away from the transmitter. Though no regularity in their relative intensity is noticed, the time intervals are absolutely constant thus supporting the hypothesis that echoes are caused by multiple reflection between the earth and the ionised layer.

Magnetic Properties of Wood Ashes.

E. WEDEKIND has recently investigated the magnetic properties of the ashes of a large variety of woods in the Forest Academy of Hannover Münden and his results have been published in *Naturwissenschaften*, **21,** 24, 1933. He finds that most ashes have distinct ferromagnetic properties, due probably to the presence of iron as magnetite. The magnetisibility is dependent on the strength of the magnetic field and even minute differences in the iron percentages have apparently quite a considerable influence. As all the woods that were investigated were grown on the same kind of soil, differences in the constitution of the same are eliminated. It was found that the magnetisibility decreases in the order : larch-pine-fir-Scots-fir-oak-beech-ash-alder-birch. The preparation of the ash from the wood was carried out by a uniform method and the temperature was not allowed to raise above 600°. Higher temperatures apparently decrease the magnetisibility by chemical or physical processes. The ashes, obtained thus, even show differences in the colour, etc.

It would be very interesting to find out why certain plants possess a higher absorption capacity for iron and what influence this factor has on the other properties of the wood obtained from them.

Abundance Ratios of (rare) Isotopes.

[H. Kallmann and W. Lasareff. *Zs. f. Phys.*, **80,** 237, 1933.]

BY means of some improvements effected in the mass-spectrograph (using an electrometer whose reading gives the intensity of the mass-spectrum line) the authors have determined the abundance ratio of O^{18} to be 1/630 of O^{16} while the intensity of O^{17} could not be measured. By comparison of their results in Neon with previous determinations they find that the intensity of a mass line does not depend on the conditions of discharge in their form of apparatus. This is important since there are variations of more than 100% in the intensity ratios of isotopes deduced from band spectra, due to variations in the conditions of excitation (see F. A. Jenkins & L. S. Ornstein, *Proc. Kon. Akad. Wet. Amsterdam*, **35,** 1212, 1932). Thus $C^{13}:C^{12}=0{\cdot}2$ in stellar spectra, 0·005 in the furnace spectrum and somewhat larger in the Mecker flame and vacuum tube, but C^{13} does not at all occur in the arc. With

the new apparatus the authors find that $Ne^{20} : Ne^{21} : Ne^{22} = 93 \cdot 7 : 1 : 9 \cdot 75$. They have also found traces of another isotope of mass 23 whose intensity is 1/2000 of that of Ne^{20} and they think that the corresponding mass spectrum line must be due to a new isotope and not to $Ne^{22}H$, since such compounds do not occur in other rare gases. Working with HCl they find also another chlorine isotope Cl^{39} which is 1/1920 times as intense as Cl^{37}. Using negatively charged ions they found that $Cl^{39} : Cl^{37}$ as 1 : 1850. Hence the result, $Cl^{39} : Cl^{37} : Cl^{35} = 1 : 1850 : 6000$. Cl^{40} did not occur; if it exists at all it is less than 1/10000 of Cl^{37}.

Optical Orientation in Felspars.

A VERY interesting paper on "Permanent changes in the optical orientation of Felspars exposed to heat" has been recently published by F. W. Barth (*Norsk Geol. Tidsskrift*, **12**, 1931) and the following new data are furnished on this subject:

"Orthoclase frequently exhibits conspicuously large changes of the optic axial angle, whereas the position of the optic indicatrix remains unchanged. It was found to be a general rule that the more potassic the felspar the bigger the change.

Microcline is *not* changed by heat treatment. Since it has been claimed that microcline, if heated long enough, will slowly invert to orthoclase, it is worthy of notice that this assertion is proved to be false.

Albite and oligoclase are very slightly changed on heating.

Labradorite exhibits appreciable alterations of both the position and shape of the optic indicatrix."

Time-Variation of Gravity.

[Tomaschek and Schaffernicht. *Ann. d. Physik*, **15**, 789, 1933.]

ACCORDING to Couvoisier the cosmic motion of the earth should result in a diurnal variation of gravity by about 6×10^{-8} of its value, *i.e.*, by about $5 \cdot 9 \times 10^{-5}$ cm./sec^2. The authors describe a gravity meter which is claimed to be capable of detecting a variation of 10^{-9} of the value of gravity. A long spiral, about 18 mm. in radius and made of Krupp's elinvar steel wire of 0·5 mm. radius, is attached to a torsion head at the top and to a small pulley at the bottom. A rod attached to the pulley along its axis carries a gilded weight of 52·5 grm. The spiral weighs 12 grm. and when stretched by a weight of 52·5 grm. its length is 110 cm. The pulley is supported partly by a bifilar suspension of phosphor bronze, 43 cms. long, attached at the ends of a diameter. The torsion head can be rotated and its position can be read correct to 20″. It is also capable of being moved up and down to within 10^{-3} mm. so that the part p of the weight balanced by the bifilar suspension can be varied. By making p small and rotating the torsion head so that the pulley is in a position of critical equilibrium, the slightest alteration of the length of the spring is made to cause a rotation of the pulley. This rotation can be detected by means of a mirror fixed to the rod which carries the weight. This weight forms part of an attracted disc electrometer and the change of weight compensated by a potential of V volts is $0 \cdot 945 \times 10^{-11} g V^2$. The whole apparatus is enclosed in an evacuated vessel and an attached barometer and thermometer indicate changes of pressure and temperature amounting to 10^{-2} mm. of mercury and $7° \times 10^{-4}$ respectively. Automatic records of the motion of a spot of light reflected from the mirror clearly show the daily periodic variations due to the lunar tide and to the declination of the moon, but no effect of the nature predicted by Couvoisier's theory is observed. The expected value for this effect at Marburg was $3 \cdot 2 \times 10^{-8} g$ and could have been easily detected. The authors conclude that a Lorentz contraction of the earth cannot be detected even by its gravitational effects just as it cannot be made manifest by electrodynamic experiments.

Recent Researches on Vitamins.

A SURVEY of the latest researches on vitamins is the subject of a special article in a recent issue of *Nature* (**131**, 118, 1933). After drawing attention to Prof. J. C. Drummond's useful summary of the position (*J. Roy. Soc. Arts*, **80**, 949, 959 and 983, 1932), the reviewer draws attention to the more important findings of the past few months. There is increasing evidence to show that narcotine derivatives possess no antiscorbutic properties: on the other hand, the identity of the antiscorbutic factor in lemon juice with a hexuronic acid (ascorbic acid) is gaining support. It is now generally agreed that crystalline vitamin B_1 contains sulphur: the recent observation of Guha and Chakravarty that ultra-violet irradiated

adenine sulphate possesses the properties of that vitamin would appear to bring us nearer to its synthesis than ever before. Vitamin B_2 would appear to be a neutral substance with a higher molecular weight than vitamin B_1. The preparation of a crystalline compound with vitamin B_4 activity and an empirical formula $C_4N_4H_5Cl$ has been described. Karrer and his co-workers suggest that vitamin A is an unsaturated alcohol with the empirical formula $C_{20}H_{30}O$ or $C_{22}H_{32}O$, an observation which is supported by the work of Heilbron, Drummond and their co-workers. Owing probably to the presence of substances which interfere with the development of the blue colour, the Carr-Price reaction does not yield results which are in keeping with those obtained by biological methods. The intensity of the band at 3280 Å in the whole oil appears to be a very satisfactory measure of biological activity. The mechanism of the transformation of carotene into vitamin A is still obscure: the conversion occurs, presumably, in the liver but there is no evidence to suggest that it is brought about by an enzyme. Deficiency in vitamin A leads to increased nitrogen metabolism resulting in less nitrogen being deposited in the body and more being lost by excretion than when the supply of that vitamin is adequate. The growth-promoting and anti-infective properties of vitamin A are due to its ability to maintain a normal structure in the different tissues of the organism. The isolation of crystalline vitamin D has reduced the interest in biological tests for the antirachitic vitamin. Mention should however be made of the prophylactic radiographic method of Bourdillon and Bruce, bone analysis of Hume, Pickersgill and Goffikin, and analyses of 'line' test and growth-promotion studies of Key, Cowart and Morgan. The review ends with a suggestion that a dietary survey should be carried out to determine the extent to which the various minor diseases are traceable to deficient intake of vitamins. It need hardly be added that similar surveys carried out in the different provinces of India will lead to findings of considerable practical importance.

Method of Manufacturing a Leather Substitute.

[*Ind. Pat.*, No. 18519 dated 23rd November 1932.]

THE above invention by Seiichi Yamamoto, a Japanese engineer, relates to the utilization of the bark of *Arto carpus Kunstleri* known also by the name, 'Kayutarap' in the South Sea Islands. The bark contains a very strong fibre together with 8–12 per cent tannin. The latter is removed by either extraction or spontaneous fermentation: the residue is opened in a wet condition with a roller or by beating to make a coarse network. The clean fibrous product thus obtained is pasted together with couchoc or balata dissolved in a volatile solvent with sulphur, pressed and finally steamed for vulcanization. Boards of artificial leather are thus obtained which have a pleasing appearance, are flexible, elastic, water-proof and resistant to mildew and possess at the same time, high tensile strength comparable only with leather of best quality.

There are numerous trees and shrubs in India the barks or stems of which contain fibre of the desired quality. It is not improbable that some of them may be useful for manufactures similar to those claimed in the above patent.

Science News.

Mr. K. R. Venkatasubban, Science College, Trivandrum, has sent a note in which he records a case of abnormal strobilus of Lycopodium, section Phlegmaria.

* * *

Miss Oldroyd's note on "Liverworts and Fern Sporophytes" published in *Cur. Sc.*, **1**, 7, 216, suffers from the defect that the specific name of the plant is not mentioned. Rai Bahadur Professor Shivaram Kashyap and Mr. A. C. Joshi of Benares Hindu University draw the attention of the author that the specimen she has described is *Gymnogramme leptophylla Desv.* and that the observation she has made has already been recorded by previous authors.

* * *

MR. M. KRISHNA MENON, University Zoological Laboratory, Madras, writes:—

"Larvæ of Decapod Crustaceans form an important constituent of the plankton of the Madras coast. Large numbers of them belonging to most of the families of the order were captured soon after the rains. This abundance seems to be due to the fact that the adults begin to breed as soon as the rainy season has set in. Their number falls gradually towards the close of March and in April; but in the succeeding four months which form the hottest part of the year the fall is sudden and considerable. Further, it has been noticed that the larvæ occurring in the townet collections of these months belong mostly to Anomura and Brachyura. They occur also

during the other months so that they can be considered as fairly permanent constituents of the plankton. It would seem, therefore, that these larvæ are more hardy and better fitted to endure the variations in the physical and chemical properties of sea water during different parts of the year. Several Decapod forms, however, appear only for short periods, being practically absent during the rest of the year.

These general observations were made while I was engaged in 1932 in a detailed study of the larval histories of 4 forms, *viz.*, *Acetes sp.*, *Callianassa sp.*, *Hippa asiatica* and a form belonging most probably to the sub-family *Upogebinae*. The work has now been completed and is being published in the next number of the *Madras Museum Bulletin*. Further study of other Decapod larvæ will be taken up in 1933."

* * *

Aluminium and Zinc as Water Softeners.—DR. B. S. SRIKANTAN, D.Sc., Chemical Laboratories, College of Engineering, Guindy, Madras, writes:—

"It is found that aluminium powder and also mixtures of aluminium and zinc powders when shaken with hard water render it soft. Aluminium removes only the temporary hardness in less than two hours. Plenty of evolution of carbon dioxide takes place and a white precipitate is thrown down. It is not capable of removing permanent hardness. The reaction could be represented by

$$MgO, 2CO_2, H_2O + 4Al + 3O_2 + 6H_2O \rightarrow 2Al_2O_3, 6H_2O + MgO, H_2O + 2CO_2$$

Permanent hardness due to $CaSO_4$ and $MgSO_4$ is removed by mixtures of aluminium and zinc. A mixture of *Al* and *Zn* in the ratio of 1:10 was found to be the best. Hydrogen is liberated in this case. The reaction is perhaps due to the incipient electrolytic action of the *Al-Zn* couple resulting finally in the adsorption of the SO_4-ions on the surface of these metals.

In all cases hard waters with definite amounts of bicarbonates and sulphates of calcium and magnesium dissolved in them were prepared and examined. The *Al-Zn* couple is so effective that the resulting soft water fails to give the usual test for the radicle. A few of the results are cited here.

Hardness of water due to	Degree of hardness Before	After	Softener
$Mg(HCO_3)_2$	50·5	1·2	Aluminium
$CaSO_4$	61·6	1·0	Al–Zn.
$MgSO_4$	62·5	1·5	Al–Zn.

For Laboratory tests trials were made with 10 gm. of the softener and 2 litres of hard water. Technical details are being worked out."

* * *

Gall in the Mango Fruit.—DR. T. R. SESHADRI and MR. G. SESHADRI IYENGAR, Agricultural Research Institute, Coimbatore, in the course of a communication, write:—

"Though the existence of galls in parts of the mango tree such as the stem, leaves, etc., has been frequently noticed and studied, there does not seem to be any mention in the literature about the occurrence of galls inside the mango fruit. A peculiar case of gall in the fruit was noticed in a variety called 'Neelam' fairly common in Coimbatore. It is a rather small sized fruit with a thick skin which is usually light yellow, the mesocarp also being of the same colour. It is sweet and non-fibrous. It is frequently found to be attacked by beetles and when the fruit is cut, one or more of them emerge from holes in the nut. The specimen herein described contained, however, no beetles and the nut was entire though very undersized and thin.

The gall was found to be in the form of nodules which were rather hard to eat and which filled most of the fleshy portion of the fruit. On making a hole at one end of the fruit and squeezing it, the thin nut along with a small quantity of fleshy matter come out. The gall remained inside and was found to be sticking to the skin fairly firmly.

The photomicrographs of the section of the gall reveal prominently the thickening of the cell walls and the existence of granular bodies inside the cells. From micro-chemical tests it is found that the cell walls are not made up of cellulose but that they are mostly cutinised with lignin-formation in certain of the highly thickened portions. The granules inside the cells consist of starch."

* * *

Mosquito and Charophyta.—MR. S. C. DIXIT, M.Sc., Wilson College, Bombay, writes:—

"There is a remarkable statement in the Presidential address of the Botany section of the last Science Congress published in *Current Science* (January, p. 208). It says: "It is reported that mosquito larvæ do not flourish in water in which Characeæ are growing. If this should prove to be correct, then we have another method of getting rid of the larvæ."

Recently Mr. B. P. Pal has discussed the same topic at length in his paper on Burmese Charophyta (*Linn. Soc. Jour.*, **49**, 327, p. 61). Mr. Pal says: "It is highly probable, therefore, that the supposed larvicidal properties of Charophyta are non-existent."

The writer has been working on Charophyta and his observations confirm Mr. Pal's results. Mosquito eggs are laid mostly in shallow and stagnant water irrespective of Charophyta. The problem should, therefore, be studied in relation to the depth, stagnation and the size of water-holding area.

At Santa Cruz near Bombay there are vast areas covered by Charophyta: yet this place is full of mosquitoes.

Larvicidal effect of Charophyta seems to be one of those fallacies wherein a scientist occasionally gets entangled."

* * *

At the Section of Mathematics and Physics of the last Indian Science Congress, Prof. S. K. Mitra read an interesting paper on investigations carried out at Calcutta on the ionised regions of the upper atmosphere in Bengal by wireless echo method. The results so far obtained indicate that (*a*) there are two distinct ionised regions, the so-called E- and F-layers, (*b*) there is a marked diurnal change in the heights of both these layers and in the intensities of the echoes therefrom, (*c*) the multiplicities of the echoes are most prominent during the sunset and sunrise periods, (*d*) the number and intensities of echoes increase as one moves away from the transmitter. The observations were carried out at various places within a radius of 8 km from the transmitter, with a mobile receiver fitted up in a motor bus.

To demonstrate the observed results before a large audience, a cinematographic record of the echoes was obtained on a film. This was exhibited to illustrate the important features of the echoes. The oscillograph employed for filming was the

Cossor c-type and the camera was Zeiss kinema. The experimental portion of the work was done by Mr. H. Rakshit, M.Sc.

* * *

At the Annual General Meeting of the Indian Chemical Society, held on Tuesday, the 3rd January 1933, at Patna, the following office-bearers were elected for the year:—

President—Dr. N. R. Dhar, *Vice-Presidents*—Dr. H. E. Watson, Dr. J. N. Mukherjee, Dr. H. K. Sen, *Hon. Secretary*—Dr. P. C. Mitter, *Hon. Treasurer*—Dr. P. Neogy.

* * *

Under the auspices of the Mysore University, Prof. B. S. Madhava Rao delivered two extension lectures on "Recent Developments in Astrophysics". In the first lecture the galactic system, extragalactic systems, Shapley's recent cosmological scheme of galaxies, super-galaxies and meta-galaxies, all included under the general head of "space-time complex", were described, followed by an outline of the scheme of evolution as developed by Jeans and the theories of the origin of the solar system. In the second lecture recent theories of stellar evolution were detailed. The relation between luminosity and effective temperature leading to the importance and evolutionary significance of the Russel diagram, Eddington's pioneer work on radiative equilibrium, and the theories of Eddington, Jeans and Milne on Stellar Stability were then described. The relative merits of the three theories were argued and a strong case made out for that of Milne.

* * *

We acknowledge with thanks the receipt of the following:—

"Journal of the Indian Mathematical Society"—Vol. 19, No. 11, Oct. 1932.

"Indian Forester"—Vol. 59, Nos. 1–2.

"Chemical Age"—Vol. 28, Nos. 706–710.

"Nature"—Vol. 131, Nos. 3298–3301.

"Education in India in 1930–31."

"Scientific Indian"—Jan. 1933.

"The Nagpur Agricultural College Magazine"—Vol. 7, No. 3, Feb. 1933.

"Berichte Der Deutschen Chemischen Gesellschaft," 66 Jahrg, Nos. 1–2.

"Brooklyn Botanic Garden Record"—Vol. 22, No. 1, Jan. 1933.

Report of the Indian Chemical Society for the Year 1932.

42nd Annual Report of the State College of Washington, Agricultural Experimental Station, Pullman, Washington.

"Journal of Nutrition"—Vol. I, No. 6.

"Bulletin of the U.P. Academy of Sciences"—Vol. 2, No. 2.

Reviews.

THEORY OF HEAT. By Prof. Max Planck (translated by Prof. H. L. Brose), pp. viii+301. London: Macmilian & Co., Ltd., 1932. Price 12*sh*.

The book under review forms the last of the five volumes on theoretical Physics by Prof. Max Planck, the distinguished originator of the quantum theory. The great merit of the work lies in assigning in the scheme of physical thought a proper place to the science of heat in which the laws of Newtonian mechanics were found for the first time to give way to the principles of quantum dynamics. The book is entirely theoretical and makes no claim to deal with experimental physics. The exposition throughout the book is very lucid and masterly which is characteristic of Prof. Planck's writings.

The book is divided into four parts dealing with thermodynamics, conduction of heat, radiation, statistical mechanics and the theory of quanta.

The treatment of the subject of thermodynamics closely follows the plan adopted by the author in his well-known treatise on Thermodynamics which has been widely appreciated by scholars and is almost a classic on the subject. The narration and deduction of formulæ are nearly identical with that of the other treatise and the reader readily perceives the similarity on a casual glance of the book. Some less important portions not directly connected with heat have been omitted, while at some other places the treatment has been slightly condensed without in any way impairing the lucidity and the logic of the exposition. The argument has at few places been modified as in the proof of the principle of increase of entropy (pp. 63–65) which is preceded by an exposition of the nature of the temperature and entropy functions.

Part II begins with a discussion of the application of the laws of thermodynamics to the theory of heat conduction. It is interesting to find the application of the second law to this subject, but one would wish to see its consequences worked out further. Next follows the investigation of a number of mathematical problems on heat conduction. Unfortunately an error appears to have crept on p. 139 where in the 6th line there should occur 'reversible' instead of 'irreversible'.

Part III deals with the theory of heat radiation and follows the plan adopted by the author in his well-known book entitled 'Heat Radiation' (Warmestrahlung). In deducing Wien's displacement law the author

has started with the concept of entropy radiation and applies the laws of geometrical optics to the propagation of this entropy radiation. The deduction is logically very elegant.

Part IV deals with the statistical and the quantum theories of heat. It gives a very clear and logical account of the subject-matter leading up to the quantum statistics and Planck's law of distribution of energy. The last chapter deals briefly with the evaluation of the sum of states, the deduction of gas laws, chemical constant and connected topics. The chapter could have included with advantage accounts of the application of the quantum theory to specific heat of solids and gases, of Bose-Einstein and Fermi-Dirac statistics.

The book thus gives an authoritative account of the theory of heat leading up to the modern developments such as the quantum theory, statistical theory and quantum statistics. The exposition is very lucid and logical and the book will form a valuable addition to the literature on Heat in English.

M. N. SAHA.

* * *

TEXT-BOOK OF PALÆONTOLOGY. By Karl A. Von Zittel. Translated by C. R. Eastman, revised with additions by Sir Arthur Smith Woodward. Vol. II with 533 illustrations, pp. xvii+453. Price 30 shillings nett. Macmillan & Co., Ltd., London.

The second volume of Zittel's series of Text-books of Palæontology has been out of print for some years and its publication, revised and in many cases rewritten so as to incorporate many new discoveries made since the publication of the first English edition, will be widely welcomed. The original form of the book remains the same and the method of treatment adopted by the author is still preserved. This volume deals with vertebrates upto mammals which are treated in the third volume.

We have no hesitation in saying that the book is an excellent work of reference in the hands of experts, but we doubt very much if it can be used by the general student of zoology or for class purposes. It is really a systematic work with figures and illustrations useful for taxonomic purposes. The definitions and diagnostic characteristics might with great advantage have been rendered fuller so as to make the usefulness of the book more general. A uniform treatment of the several fossil groups is impossible of attainment unless our knowledge of them is as complete as that of living forms and a systematic work like that of Zittel's text-books can only be used with great caution and with obvious limitations by students of general palæontology.

The study of zoology is incomplete without a proper training in Palæontology and provision is accordingly made in the syllabuses of zoology for the inclusion of the study of fossil forms. The evidence furnished by the animals in remote ages to the evolutionary concept of life is indispensable to the teaching of zoology and viewed from this standpoint the book furnishes very few materials. For instance, the evolution of the caudal structures of fishes is an extremely fascinating subject; the inter-relationships of the vertebral elements in the different parts of the dorsal axis, and structure of the skull are other interesting studies which should have been discussed in the introductory section on Pisces. To students of zoology and general palæontology, the origin of pentadactyle limbs of Tetrapoda possesses great attraction and in the chapter on Amphibia, one would expect to find a reference to the numerous theories which have been advanced to derive the tetrapod limbs from the gill arches and fins of fishes. In the chapter on Reptilia the description of the vertebral column should have included a discussion on the evidence provided by the Stegocephalia and Proreptilia in regard to the difference in the development of the vertebræ in the groups Amphibia and Reptilia. Similarly the description of the atlas of crocodiles might have been made fuller by comparison with its structure in *Metrorhynchus* and *Sphenodon* and pointed out how the epistropheous has come to bear two ribs. There are several other subjects which could have been treated from the standpoint of comparative study and we have no doubt that such a treatment of the subject would have made the book an invaluable possession to students of zoology.

But for these details which certainly would enhance the value and usefulness of the book, we have a genuine regard for the excellent and lucid method of exposition adopted in the treatment of what is generally regarded as dry and uninviting portion of palæontology. The illustrations include old figures of actual fossils and several new ones have been incorporated, taken from the fourth German edition, besides diagrams from original papers. The bibliographies under different sections have been enriched

by the addition of newer literature and this is a source of great advantage to students working on any particular group.

The introductory chapters which are intended to be general introduction to the various classes give sufficient information for pursuing the study of the anatomy of the fossils comprehended under them. We welcome this English edition of Zittel as a great addition to our works of reference which will provide the necessary guidance and stimulus to all students interested not only in the study of palæontology but also in general zoology.

C. R. N.

* * *

VON DAVY UND DÖBEREINER BIS DEACON, ein halbes Jahrhundert Grenzflächenkatalyse. (From Davy and Döbereiner to Deacon; A Half Century of Contact Catalysis.) By Alwin Mittasch, and Erich Theis. Verlag Chemie G.m.b.H., Berlin, 1932. 278 pp. Price Mk. 18·50.

A history of chemistry may be of the descriptive type in which case it must suffer by the omission of many material facts or it may be encyclopædic and consequently somewhat disjointed and uninteresting. The authors of the volume under review have endeavoured to combine the advantages of both types by adopting a system of comprehensive foot-notes which occupy some 25 per cent. of the whole volume; the main text has in consequence a fair degree of continuity, but it is still to be noticed in many cases, that those pages with the fewest foot-notes afford the most pleasant reading.

There is no doubt regarding the encyclopædic character; the authors appear to have taken immense pains to let no reference to contact catalysis, however insignificant or obscure, escape their notice. Many little-known facts have thus been brought to light and curiosity aroused regarding the life and work of authors whose names are unfamiliar. It is only to be regretted that in a work of modest dimensions fuller details cannot be given.

As a description of contemporary thought and work the book is less happy. The most interesting chapters are those dealing with platinum and the synthesis of ammonia, as these are in the nature of a review of the ideas of all who were interested in these outstanding problems of their time. The remainder is somewhat disjointed, as is bound to be the case when a single subject is considered. The value of studying the lives of great scientists lies largely in following the line of thought which led from one discovery to another and in examining their methods of conducting experiments with the crude apparatus available. The authors have done what they can to bring in the personal element by the inclusion of illustrations, sketches of apparatus and occasional quotations but in spite of this there remains a feeling that something is wanting. The reason is undoubtedly the presence of so many references, but as these form an essential part of the work, it is evident that the failing is one that cannot be corrected. Too much attention should not therefore be paid to this aspect. The real value lies in the thoroughness with which the matter has been compiled and as a book reference for all who are interested in the history of chemistry and students preparing for examinations the volume can be highly recommended.

H. E. W.

* * *

LEHRBUCH DER ANORGANISCHEN CHEMIE (Text-book of Inorganic Chemistry). By Dr. Heinrich Remy. Akademische Verlagsgesellschaft m.b.H., Leipzig, 1931. Vol I, xxii+718 pp., 92 figs. Vol. II, xvi+450 pp., 32 figs. Price, Vol. I, RM. 20; Vol. II, RM. 14.

The most noteworthy feature of this new text-book is that in the small range of two volumes consisting of about 1,150 pages, the field brought under survey includes not only the whole of inorganic chemistry, but in addition the theoretical aspects of general and physical chemistry with their applications to special problems. The first volume deals with the elements of the sub-group A of the first three groups and the sub-groups B of the next four groups of the periodic table. The elements of a single family (*e.g.*, lithium, sodium, potassium, rubidium, caesium) are treated together in one chapter which presents at the outset the results of recent work concerning their general characteristics, such as normal potentials, ionic and atomic radii, crystal structure, compressibility and spectra, along with their methods of preparation and chief uses; the larger part of the chapter, however, is devoted to a descriptive account of their compounds. The second volume covers the elements not treated in the first volume and these include the transition groups and the rare earths, the method of treatment being similar to that adopted in the first volume.

Important considerations of theoretical chemistry such as Bohr's theory of the hydrogen atom, Kossel's theory of valency, X-Rays and crystal structure, and the co-ordination theory of valency, are dealt with very clearly in separate chapters in appropriate positions of the first volume. Although the usefulness of the book is unquestionably enhanced by this procedure, it is to be regretted that it has entailed the curtailing of portions dealing with preparative and analytical chemistry. The second volume, however, is free from this drawback and gives as full an account of the elements and compounds coming within its scope as is to be found only in much larger treatises.

The two volumes of this work form a valuable addition to the existing text-books of inorganic chemistry and are certain to prove of great use to students of chemistry in the honours courses of our universities as well as to lecturers on the subject.

K. R. K.

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CONTENTS.

Examinations and Education.

ONE of the reasons why examinations have acquired a vicious influence and undue importance in some of the Indian universities is that they constitute the only avenue for preferment in government service and more recently other employing agencies also have begun to appreciate the value of higher education in their servants. This intimate association of a purely academic function with the economic and service problems must necessarily produce a baleful effect upon both. The vision of an educated young man is restricted by the four walls of the office room and he devotes all his energies to pass his examination for the realisation of his modest ambitions. Government should have at their disposal means other than the university examinations for discovering those qualities in their employees for the proper and efficient performance of administrative duties but the touching confidence they have all along reposed in the universal efficacy of these tests is a credit to the honesty of the whole transaction. This relationship has unfortunately exposed the system of education and examination to the unmerited criticism that they are a cause of the evil of unemployment among the educated young men. In India failure in an examination amounts almost to forfeiture of one's social status and the young men whom the universities reject annually have no alternative except to pass through life like a perpetual blister. The remedy seems to be to throw open those services for their absorption, which are at present treated as close preserves and to encourage settlement on the land, to promote cottage and minor industries and to facilitate emigration.

The prevailing dissatisfaction and the public criticisms which we repeatedly hear in regard to examinations will on ultimate analysis be found to lie in three defects which have unconsciously been permitted to creep into the system. Those who are conversant with the history of education in India might remember that in Tols and Patasalas, there was abundance of good learning but little or no examinations. In the ancient universities of India, the process of weighing knowledge attained by the scholars used to take the form of disputations among themselves, in which they were permitted to engage under the presidency of their teacher and in

accordance with the well-known rules of debate. Viewed from any standpoint, an examination is essentially in the nature of a contest. If this view be correct then it follows that justice and fairplay require that the scholars themselves should be permitted to find out the profundity or otherwise of each other's learning and the function of the teacher should be restricted to the maintenance of the standard and the appropriate rules of disputation. The professor in the ancient universities did not enter actively into these literary contests for he was conscious that his vast store of learning and his highly sophisticated mind with its powers of defeating the opponent would be unfair implements to be used against young and growing minds and the whole engagement would be unnatural. In our present-day academic tests we are employing methods which can never be permitted in physical contests and athletic sports. Our public examinations are not different from a five days' cricket test match in which a hundred youthful players are gathered at Lords, trained for four years in different centres by coaches whose skill and proficiency are not of the same order and under conditions of equipment never uniform. These young men are called upon to defend their wickets and in a single over are required to hit boundaries against professional bowlers who however are asked to adjust the pace, length and spin of the ball to the level of the skill and attainment of the juvenile team. These bowlers constitute themselves into referees to declare l.b.w., decide boundary hits and all other intricate and delicate problems in the decision of which one of the parties is to maintain absolute silence and to give unquestioning acquiescence. If this is a fair game then the university examinations are only artistic perfections. The examiner enters the lists throwing out the challenge of a question paper to be picked up by the young aspirants for laurels; he determines the rules and declares the issues of the contest and it is no wonder that the young men treat it all as a game of manœuvres in which they employ all the instruments which their external supporters have placed in their hands for confounding their assailant. The system which we have evolved is inevitable in view of the magnitude of the material to be dealt with and the speed and simultaneity of action involved. Its merit perhaps is that it is impersonal in its dealings and uniform in its applications. However, it cannot escape the charge th for purposes of measuring the amount intellectual proficiency that the young ma has acquired during his four years' trainin we have introduced weights which are of totally different order and which alwa succeed in discovering the want of kno ledge. We have travelled far too great distance in organizing our educational i stitutions to be able to restore the mo natural scheme of examinations once pr valent in the ancient universities.

Perhaps a graver defect of our existi system is the negative correlation of t age of the pupils and the total amount knowledge they are required to bring up f the examination. A candidate whose age eighteen years and who appears for t degree examination is expected to read abo twenty books (and more in the case of intermediate candidate) and to acquire co plete and detailed knowledge of every o of them to be ready to be reproduced a given moment in an ideal form. V forget that the contents of each book rep sent a body of knowledge in the buildi of which several adult minds have labour incessantly over long periods of time a if the author of the book were required to for an examination it is doubtful if he w get the necessary minimum mark. In fa we are asking the young men to perfo a task which it has taken the human ra ages of unremitting work to complete a to consolidate. The examiners besides ha little patience with the candidates wh they commit errors and it would be u natural for a young man not to do so, fo growing mind must necessarily trace t lines along which the racial mind has trav led in the quest of knowledge. The histo of the rise and growth of science reve the fact that adult minds were not infalli and if we excuse the mistakes made experienced adult minds working in a f atmosphere, with plenty of leisure and the resources of reference and perso consultations, what justification have to reject the candidates for committ similar errors which are inevitable in t feverish state of their mind working u assisted against time? Public examinatio make little allowance for, nor recogn the biological history of the human m and the arbitrary standards we have set for the young men will stagger the auth themselves and in almost every case if t question paper setter were required

answer his own paper within the limited time permitted to the candidates, it is doubtful if when his answer scripts are valued by his colleagues, he will get marks sufficiently high to place him in the first division.

Another defect which is perhaps inseparable from the existing conditions is the medium of instruction and examination. All the energy of the Indian student is spent in acquiring mastery over a foreign language and very little is left to develop a deep acquaintance with the subject-matter. From this handicap, his cousins elsewhere are exempt. This must account for the very superficial knowledge which the bulk of the candidates present at the public examinations and in marking their papers no allowance is made for the inadequacy of expression due to a fundamental defect in the organization itself. In India where there is a multiplicity of languages, the problem of instituting a common medium of instruction and examination is really fraught with difficulties arising from various causes. But if her people are determined to place their country in the forefront along with others which lead in the world of science and education, they must sacrifice sentiment and put aside all other considerations than those of the true interests of the nation. A common language for imparting instruction to the youth of the country is possible provided the people will to adopt it and in case they are to decide in favour of that virile and widely spoken language, Hindi, then the commencement should be made in the lowest grades of instruction and books in all branches of knowledge would have to be written. This is almost a task of insuperable difficulty but if the cause is good enough, the trouble alone should not deter its being undertaken. If, however, the psychologists were to prove that Hindi would offer the same difficulties to the non-Hindi pupils as English presents to both, then we have to revert to the days when in South India, English was used in the instruction of all subjects excepting the vernaculars in the middle school grade and endeavour to improve the methods of teaching in such a way as will reduce the obstacles to the acquiring of mastery over it for purposes of free and full expression. The difficulty in assimilating a foreign language is not inherent in it nor is it that an Indian student lacks power to master it but it arises entirely from faulty methods of teaching, the prescription of unsuitable books and perhaps also in some cases from want of competence on the part of the teachers.

At present the undue importance attached to examinations and the unpsychological methods in which they are conducted are exercising a pernicious influence on education which is frequently adjusted to comply with the requirements of their arbitrary standards. The improvements of education are always conceived in terms of the examinations which are considered to be its fitting conclusion. It is the common experience of all Universities that where examinations are permitted to direct and dominate their activities, post-graduate work on the part of such universities tends to counteract. It ought to be possible to strip the Indian university examinations of the terrible aspect which they now wear and make them a part of the regular educational work as they have done in America and most of the European countries. A great and radical reform of examinations is overdue and we feel that this task ought to be entrusted by the Indian Government to the hands of a Commission of educational experts.

One of the reforms that we are thinking of at the present moment refers to the practical examinations in scientific subjects for the B.A. and B.Sc. Pass Degrees and the Intermediate subjects in which practical examinations are conducted. The prevailing practice of assigning an independent problem to be worked out by separate candidates taking physical sciences or a common problem as in the case of those electing biological studies, is unsound as an educational principle. The requirements of the Honours candidates who take a more specialised course over a more prolonged period are different, for their scientific outlook and their intensive training demand evidence of a capacity for continuous application in the investigation of a special problem or the elucidation of complex structural relation in the material provided, including the presentation of a scientific report on the collections of specimens. The scientific courses prescribed for the ordinary pass degree aim at a cultural training while the Intermediate stage attempts at an illuminating general introduction to science. The practical examinations for these candidates ought to be devised to test their acquaintance with the general use of

apparatus, their principles of construction, their working parts and how they are fitted for the purposes for which they are intended, with taking readings, testing and handling particular parts, making connections and so forth. While dealing with the range of the practical acquaintance of each of these assembled pieces of apparatus the examiner has the invaluable opportunity of testing the mental alertness of the candidates whom he takes through an easy *viva voce* examination as well. Similarly in the biological studies, the use of several instruments and how and when to employ them, the identification of specimens with a short account of their structure, habits and modes of occurrence and the description of gross and microscopic preparations will reveal the potentialities of the candidates' mind which the prescription of a definite problem will fail to discover. The scope of the practical examination should be limited to testing the knowledge of the candidates of the apparatus in common use in the laboratory, their manipulative skill and truthfulness in recording results of observed facts. If this system in some form were found desirable to be adopted in regard to Honours examinations, the candidates should be required to give evidence of their power of adopting new methods in the use and application of the instruments and of drawing general conclusions from a mass of experimental data or field notes and observations with a view to test whether the mind works in routine or is capable of devising new methods in dealing with altered situations.

The influence that examinations now exercise on the destiny of education will relax the moment the government and other employing agencies cease to look upon them as a *sine qua non* for employment in their services. It is true that a specialised knowledge of any narrow field of science such as an Honours graduate possesses may not be of direct use in the discharge of the administrative duties, but what is invaluable in him is the disciplined training, the mental alertness and the power of applying scientific knowledge to the problems of government and those of the practical affairs of the people. Admirable as these qualities are, they are not enough in an administrator who needs wisdom, foresight, driving power, ability to command men, to organise and consolidate the forces of civic life and finally the power to take quick and correct decisions and most important of all a natural sweetness of temper. The competitive examinations which are only duplicates of universit examinations are, when applied to discove these traits of character, undoubtedly a bad test. Examinations on prescribed books o on definite fields of knowledge can be easil and successfully met by resorting to th aids provided by the ingenuity of commen tators and annotators. What the compe titive examinations really test is not th knowledge or intelligence, much less an of the personal qualities of the candidat but the amount of cunning with which h can anticipate the questions and provid the examiner with information cramme from 'tips'. There can possibly be nothin better than a wise education for the makin of public servants but little can be sai in extenuation of an employing agenc which requires the best public service an applies the wrong tests for securing it. I it impossible for the Government to devis a scheme other than competitive exami nations for the purpose of selecting compe tent and wise public servants? The meri of a competitive examination is not th logic or the fairness of it but its power t fulfil the purpose for which it is instituted Ostensibly the university examinations ar intended to test the power to think on th part of the candidates but, generally speak ing, the question papers succeed in findin out how much of literary and scientifi lumber is stored in the mind and is capabl of being unpacked. The Public Service Commission attempt nothing better. W cannot go back to the system of nominatio which is attended by fear and distrust, bu probably a scheme in which the co-opera tion of the university professors is enliste may be found more satisfactory. A pan of distinguished graduates who have show a distinct aptitude for sports and have take a leading part in the activity of the unive sity unions may be prepared by the colla boration of the professors of each of th universities for submission to the Public Se vices Commission who will proceed to invi such nominees for an interview for a detaile *viva voce* examination intended to test tho very qualities which the Government wou desire in their administrators. If this exa mination be sufficiently searching ar exhaustive the Public Services Commissic would succeed in securing for the Gover ment a band of capable officers distinguishe alike for their academic scholarship an

administrative qualities. The meaningless duplication of the university examinations can then be dispensed with, resulting in financial saving.

The problems of reforming the public examinations conducted by the universities and by other educational bodies must in their nature be numerous and complicated and would be a fitting subject for detailed investigation by a Commission to be appointed by the India Government. It is true that education is a provincial subject but its importance is an all-India question. The urgent need of assigning examinations to their proper place in the household of education where they are now playing the part of a parvenu mistress is to be recognized. We hope to be able to indicate in a future issue of our Journal the broad outlines on which the reform is to proceed.

Announcement.

Sir C. V. Raman, Kt., M.A., D.Sc., LL.D., F.R.S., N.L.

WE have pleasure in offering our felicitations to Sir C. V. Raman on the occasion of his assuming charge of the Directorship of the Indian Institute of Science, Bangalore. We hope that in augmenting the high traditions of the exalted office he is called upon to occupy, his administration of this important scientific Institution in India will witness a rapid and uninterrupted growth of fresh scientific research conducive to the general progress and industrial prosperity of the country.

The Everest Expedition.

THE successful test flight over Mount Everest by the Houston expedition will always rank as one of the magnificent achievements in the history of aviation. As a public demonstration of the British spirit of enterprise and as a deed of daring, it surpasses in interest and in romance the great enterprises of Peary and Scott. But nevertheless these undertakings cannot be compared with the maritime discoveries of the Italian sailors and the English seamen of the sixteenth century, which opened up the economic resources of vast continents for exploitation by the civilized European nations, converted the impassable oceans into commercial highways and paved the way for the spread of knowledge and civilization, besides adding to our knowledge of the human races, the fauna and flora and the geological conditions of the hitherto unknown tracts of the world.

The previous expeditions on land have not succeeded in attaining the summit of Mount Everest and the flight therefore over this highest peak is attended by more than usual interest. The Westland 'planes used by the party are provided with every equipment which modern science can devise and human resources can supply. The problems of flying in the higher altitudes are severely exacting and unexpected developments in the weather conditions may frustrate the hopes raised by the completeness of equipment, the foresight, efficiency and experience of the party. The fierce hurricanes and the poor visibility in the higher altitudes are factors which no pre-vision or calculation can provide for on account of our imperfect knowledge of the meteorological conditions and the range of their variation in upper atmosphere. The problem of warming food and the kind and quantity of nutrition required for keeping the party fit for carrying on the scientific observations have been carefully thought out and amply provided for. If the air party can establish communications and collaborate with the expedition on foot under the leadership of Mr. Rutledge the scientific results of this undertaking will be of inestimable value. It is too premature to estimate their importance or to envisage the directions in which they may be of practical value. But the knowledge gained by the behaviour of the 'planes in upper air will be of immediate assistance in perfecting the civil aviation for the promotion of peace and goodwill among the nations of the world. It is chiefly in this direction that we look forward to suggestions being made by the Houston party with a view to facilitate easy, cheap and safe communication between nations of the different countries for the consolidation of the higher destinies of humanity.

Dr. M. O. Forster and the Indian Institute of Science.

THERE is a basis of truth in the philosopher's exclamation—"Blessed is the country which has no history!" During the ten years of Dr. Forster's Directorship the Indian Institute of Science has pursued its peaceful way. There have been no students' strikes or political troubles, and a visitor to the annual gymkhana prize-giving sees nothing but happy faces and generous camaraderie. Some 400 students, including those at present in residence, have passed through the Institute during these ten years. It is no small thing that these young men go out into the world, most of them to fill responsible appointments, all imbued with sane and helpful ideals. When all is said it is probably for this that Dr. Forster's name will be remembered with honour and affection. Always accessible, always sympathetic, with an unfailing sense of humour, and scrupulous honesty, it is probable that his left hand does not know what his right hand has done. The warmth of kindly feeling shown at the recent farewell entertainment was unmistakeable.

While emphasising these things there is much of obvious progress to record. The greatest advance has been in the Department of Electrical Technology, mainly owing to the zeal and initiative of Prof. Catterson-Smith. Wireless laboratories have been equipped and a high tension laboratory and transformer room have been provided, as well as a direction-finding hut, new rooms for battery and charging equipment and a new drawing office.

Dr. M. O. Forster.

The number of students has increased from 15 to 53 and the members of the staff from 3 to 8.

The Department of Biochemistry has also developed, the number of students having increased from 16 to 31. A pot-culture house, animal house, insectory and micro-analytical laboratory are among the extensions to the equipment of the Department.

The Departments of General and Organi Chemistry still retain their supremacy i numbers, the students having increased fro 52 to 58 and the staff from 4 to 8. Exte sions in building and equipment have al taken place.

Through the generosity of Sir Dorab Tat a Students' Gymkhana Club House h come into being and is the centre of t social life of the Institute.

All these things, by whomsoever origina ed, demand for their successful carrying o constant attention and support from t Director. He too mu exercise watchful care ov important concerted r searches, such as the i vestigations on Lac a on the Spike Disease Sandal, undertaken the Institute for t Governments of Mysc and Madras respectivel

As his own persor contribution to the scien fic work of the Institu must be specially mentio ed Dr. Forster's editors of the *Journal of Indian Institute of Scien* 165 parts of the Jour have been published d ing his term of offi each of which he edited with meticul care. In this way he kept close watch o all the scientific work turned out fr the laboratories, and has been able impress his own high standards of excelle upon staff and students alike. At the cl of his tenure of office he has lent his supp to the new journal *Current Scie* which, while appealing to the scient public of the whole of India, has birthplace and headquarters at the Ins tute.

In brief then we may say that Dr. Fors hands over to his successor, Sir C. V. Ram an institution full of life and possibiliti in good status, socially, scientifically a financially. The foundations have been w and truly laid, what will the superstr ture be?

Hyperfine Structure of Elements in Mercury Arc—II.

Nuclear Moment of Caesium.

By Prof. B. Venkatesachar, M.A., F.Inst.P., and L. Sibaiya, B.Sc., A.Inst.P.

BAINBRIDGE (*P.R.*, **36**, 1668, 1930) has confirmed the earlier results of Aston (*P.M.*, **42**, 436, 1921) regarding the isotopic constitution of cæsium, *viz.*, that it has only one isotope of mass number 133. The source of discrepancy between the simple isotopic constitution of cæsium and its chemical atomic weight cannot be definitely traced until the packing fraction is correctly determined. The hyperfine structure analysis, however, is greatly simplified by the fact that cæsium atoms are all of one class with mass number 133, and no complications arising from a mixture of isotopes are at all possible. Jackson (*P.R.S.*, **121**, 432, 1928) first surmised the nuclear spin moment of cæsium to be either $\frac{1}{2}$ or $\frac{3}{2}$ in units of $\frac{h}{2\pi}$. But according to Kopfermann (*Naturwiss.*, **19**, 676, 1931) the nuclear spin is $\frac{7}{2}$ or $\frac{9}{2}$, while Schutz (*Naturwiss.*, **19**, 1007, 1931) gives for the nuclear moment $\frac{5}{2}$ as the most probable value. Thus to the nucleus of cæsium atom have been ascribed by various observers all the half integral values ranging from $\frac{1}{2}$ to $\frac{9}{2}$. White (*P.R.*, **35**, 441, 1930) however concludes that $\frac{5}{2}$ is probably the correct value from the meagre evidence obtained from the equation

$$\frac{\Delta \nu_g}{\Delta \nu_f} = \frac{m_k}{4\, i\, m_e}$$

connecting the nuclear moment i with the gross structure separation $\Delta \nu_g$ of ^{2}P levels, the electronic mass m_e, the nuclear mass m_k, and the fine structure separation $\Delta \nu_f$ supposed to be equal for both the $^2P_{\frac{1}{2}}, {}_{\frac{3}{2}}$ levels. Jackson gives that

$$\frac{\Delta \nu_f}{\Delta \nu_g} = \frac{1}{\frac{1}{2}Z} \frac{\mu_k}{\mu_e}$$

where μ_k and μ_e are the nuclear and electronic magnetic momenta respectively; whence it follows that the individual separations of the hyperfine levels of ^{2}P states are unresolvably small if we assume that $\frac{\mu_k}{\mu_e}$ is of the order of 10^{-3} after Kopfermann.

The value of the nuclear quantum number can be determined quite simply from the intensity ratio of the components of the hyperfine structure doublets. The CsI doublet $6^2S_{\frac{1}{2}} - 7^2P_{\frac{1}{2}}, {}_{\frac{3}{2}}$ (4593 Å and 4555 Å) gives two components for each line and from their relative intensity the nuclear spin can be estimated. By applying Burger and Dorgelo's intensity rule for gross multiplets to fine multiplets by the substitution of f for j, and considering the fine structure levels of $^2P_{\frac{1}{2}}, {}_{\frac{3}{2}}$ to have negligible separations, the intensity ratio of the two components becomes $\frac{i+1}{i}$ agreeing with the value obtained by Fermi from quantum mechanical considerations. In cæsium the two components have been found to be of very nearly equal intensity, so that the value of i must be high; Jackson (*Nature*, **127**, 924, 1931) says "it may well be $\frac{9}{2}$, or perhaps higher".

Since the normal atoms of cæsium can absorb $6^2S_{\frac{1}{2}} - m^2P_{\frac{1}{2}}, {}_{\frac{3}{2}}$ the effect of absorption in the source on the relative intensity of the hyperfine components needs special mention. Since the ratio $\frac{\text{emission}}{\text{absorption}}$ is the same for both the components of any one line, the stronger component will be more suppressed than the weaker one and the intensity of the two components will be rendered nearly equal as a result of the existence of self-absorption in the source. Filippov and Gross (*Naturwiss.*, **17**, 121, 1929) mention that in their source as well as in the one used by Jackson the possibility of self-reversal is not ruled out. Hence arises the necessity for re-examining the structure in a source where the effect of self-reversal is considerably reduced if not entirely eliminated. With this end in view the radiation from a vertical cooled mercury arc lamp with a tungsten anode containing a small quantity of cæsium chloride is analysed. The source answered our expectations since the use of cæsium chloride in an atmosphere of mercury vapour resulted in the great reduction of normal cæsium atoms responsible for the absorption as compared with other modes of excitation. Again the influence of the inner atomic electric fields on the radiating atoms is more marked in cases where the neighbouring atoms are in the same spectroscopic state as the radiating atoms and belong to the same element. Since the mutual influence is thus great in like atoms, an atmosphere of mercury vapour will serve to

greatly diminish the broadening effect. An analysis of the lines 4593 Å and 4555 Å by Hilger Lummer plates revealed each line as a doublet consisting of two sharp lines with a clear intensity difference. Fig. 1 shows

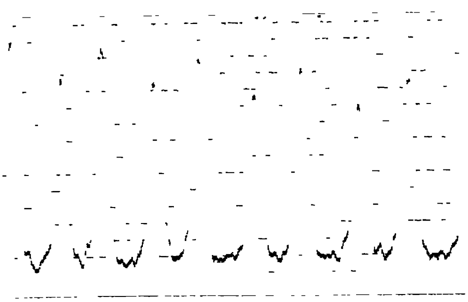

Fig. 1.

Microphotogram of the CsI Line λ 4555 Å, $6\ {}^2P_{3/2} - 7\ {}^2S_{1/2}$.

the densitometer curve of the Lummer plate pattern of the line 4555 Å taken on a Cambridge Microphotometer by Dr. A. L. Narayan of the Kodaikanal Solar Physics Observatory.

The intensity ratio of the components has been computed by using the Schwarzchild-Stark formula for the darkening D of a photographic plate that

$$D = \log k\, I^m t^n$$

where I is the absolute intensity of the radiation and t the time of exposure, k, m and n being constants depending only on the photographic plate and the wavelength of the radiation. Neglecting the wavelength difference between the components so far as its effect on the sensitiveness of the photographic plate is concerned, we obtain for the two components, whose darkenings are D and D′ and absolute intensities I and I′ that

$$\frac{I'}{I} = e^{\frac{D'-D}{m}}$$

the time of exposure for the two components being necessarily the same. The plate constant 'm' can next be evaluated by photographing the multiplet line with different slit widths for the same intervals of time, and assuming that the absolute intensities are proportional to the slit widths. An alternative method would be to determine 'm' from a hyperfine pattern of known intensity ratio obtained on the same plate, the wavelength of the line employed being as near as possible to that of the line unde investigation. A calculation of the relativ intensities of the two components from th densitometer curve has given a mean valu of $1 \cdot 408 \pm 0 \cdot 018$. Hence the nuclear spin o cæsium can be estimated to be $\frac{5}{2}$; th theoretical value of the intensity ratio a given by the relation $\frac{i+1}{i}$ would then b 1·4. The neighbouring values of nuclear spin *viz.*, $\frac{3}{2}$ or $\frac{7}{2}$ would give the theoretical rati as 1·667 or 1·286 respectively, both of whic are well outside the observed value. Fro measurements on the lines $6^2S_{\frac{1}{2}} - 7^2P$, th separation of the $6^2S_{\frac{1}{2}}$ term has been cal culated to be 0·298 cm^{-1}, agreeing wit value obtained by other observers. Ferm (*Z.P.*, **60**, 320, 1930) has shown that th separation

$$\triangle \nu = 146\, \frac{\mu_k}{\mu_e}\, \frac{2i+1}{i}$$

whence $\frac{\mu_k}{\mu_e} \simeq \frac{1}{1180}$

in agreement with the assumption made b Kopfermann. Applying Nile's correctio (*P.R.*, **38**, 375, 1931) to the Fermi formul the Lande g (I) factor of the cæsium nucle becomes 1·11. In the case of cæsiu where the 6s optical electron alone is re ponsible for the term $^2S_{\frac{1}{2}}$, its relativel large separation as compared with that ^2P terms is due to the extreme penetratio of the 6s electron in consequence of whic the coupling is very strong. The 6p electro is less penetrating, and hence the couplin is far weaker thereby producing only a ve small separation in the ^2P levels.

Since the nuclear spin of cæsium h here been determined by applying the gro multiplet intensity rule for hyperfi structure components, it may be point out that the intensity ratio of the doubl lines 4555 Å and 4593 Å deviates conside ably from the intensity rule for multiplet Hagenow and Hughes (*P.R.*, **30**, 284, 192 give ratios ranging from 2·3 : 1 to 3·8 : the higher ratio being obtained with mo attenuated sources where one would expe from Burger and Dorgelo's rule an asymtot approach to the ratio 2 : 1. Filippo (*Z.P.*, **36**, 477, 1926) obtains an avera intensity ratio of 3·81 : 1 for this doubl when the weakest possible concentration the salt was used. Kohn and Jakob (*P.Z* **27**, 819, 1926) give ratios ranging fro 3·43 : 1 to 4·25 : 1. Though the intensi

rule is thus often violated in the gross structure multiplets, the hyperfine intensity rule has been applied with confidence to the patterns of those very lines that neither obey the intensity rules nor follow LS coupling. If a breakdown of the intensity rule in hyperfine structure should however occur in any single case, the estimate of the nuclear spin of cæsium will have to be established from entirely different considerations such as the Paschen-Back effect or the percentage polarisation of resonance radiation. The observed patterns of the two lines show a wing towards the shorter wavelength side of each component and if this wing be attributed to the small ^2P fine separations, it follows that the fine levels of $7^2P_{\frac{1}{2}, \frac{3}{2}}$ are possibly inverted, those of $6^2S_{\frac{1}{2}}$ remaining regular (Fig. 2). The wings of

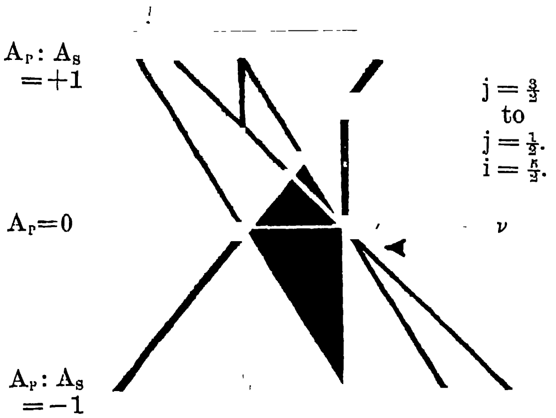

Fig. 2.

Graphical analysis of the structure of CsI 4555 Å, $6\ ^2S_{1/2} - 7\ ^2P_{3/2}$, showing that the observed pattern which fits into the diagram along the arrow is consistent with the inverted fine levels for the term $^2P_{3/2}$ with very small separation. A_P and A_S refer to the interval factors of the P and S states respectively.

the components of 4593 should then be expected to be more pronounced than those of 4555 Å, for according to Fermi

$$\frac{\Delta\,^2P_{\frac{1}{2}}}{\Delta\,^2P_{\frac{3}{2}}} = 2 \cdot 5$$

a relation which is however violated in the Tl I spectrum. Since in this investigation the chief point was the calculation of the relative intensity of the components, exposures for the patterns were necessarily insufficient to bring out the new faint satellites, if any, as in the case of cadmium or thallium (Venkatesachar and Sibaiya, *Cur. Sc.*, **1**, 264, 1933). Our earlier suggestion that such "faint satellites may be caused by isotopes present in such small relative abundance that the mass-spectrograph has not been able to reveal them" is further supported by the recent discovery of a large number of new isotopes for bismuth, lead and thallium by Miss Bishop and her collaborators (*P.R.*, **43**, 43, 1933) using a magneto-optic method.

Discussion on alkali nuclei :—The nuclear spin of cæsium from the intensity measurements on the hyperfine components is seen to be $\frac{5}{2}$. Using a source similar to the one described above in the case of sodium, each of the D lines have been found to be doublets with a separation of $0 \cdot 058$ cm^{-1} and an estimated intensity ratio of 3 : 1. This would mean that the nuclear spin of sodium is $\frac{1}{2}$, in entire agreement with the conclusions of Frisch and Ferchmin (*Naturwiss.*, **18**, 866, 1930) and Murakawa (*Tokyo Sc. Papers*) But the value $i = \frac{1}{2}$ gives theoretically 33·3% polarisation of resonance radiation, while Ellett's observed value (*P.R.*, **35**, 588, 1930) of 16·3% can only be explained if i is assumed to be equal to 1; again the band spectral data of Na_2 lead us to suspect that the nuclear spin is greater than 2. Thus the spin value determined by the intensity rule is not in agreement with that obtained by the polarisation of resonance radiation or by the band spectral calculations. In potassium also Loomis and Wood (*P.R*, **38**, 854, 1931) point out that "the phenomenon of alternating missing lines not occurring disproves the assertion, based on the failure of certain observers to find hyperfine structure, that the nuclear spin of K 39 is zero." In rubidium, on the other hand, Jackson (*Nature*, **128**, 34, 1931), using an eye-estimate of the intensity ratio of the components as 2 : 1, gives the nuclear spin of Rb 85 as $\frac{3}{2}$, while it could well be 1 in agreement with theory; he attributes the wings of the hyperfine components towards the violet to the heavier isotope Rb 87. Kopfermann (*Naturwiss.*, **21**, 24, 1933) has concluded that the nuclear spin of Rb 85 is $\frac{5}{2}$, while that of Rb 87 is either $\frac{3}{2}$ or $\frac{3}{2}$, and shows that the magnetic moment of Rb 87 is 2·3 times greater than that of Rb 85. Li 6 has a nuclear moment of 0, while that of Li 7, according to the hyperfine structure data of Schüler and Brück (*Z.P.*, **58**, 735, 1929) and Schüler

(*Z.P.*, **66**, 431, 1930), is $\frac{1}{2}$; Harvey and Jenkins (*P.R.*, **35**, 789, 1930) conclude from band spectra that nuclear spin of Li 7 is $\frac{3}{2}$. It must be admitted with Gamow that "the results obtained from the band-spectra on the one hand and from hyperfine structure on the other do not always agree; these inconsistencies may be due to the uncertainty of the experimental data, or to the wrong interpretation of the observed facts."

It is suggested that the nucleus consists of a maximum number of α-particles, one proton or none, and neutrons with spin moments of $\frac{1}{2}\frac{h}{2\pi}$ arranged in shells (Venkatesachar and Subbaraya, *Cur. Sc.*. **1**, 120, 1932). The magnetic moment of a neutron being nearly equal to that of a proton, the hyperfine splitting will be of the right order of magnitude as compared with the multiplet splitting due to the magnetic moment of the spinning electron. This approximate equality of the magnetic moments of a neutron and a proton follows directly from the measurements of Granath (*P.R.*, **42**, 44, 1932) on lithium. The magnetic effect of the spin of a free proton in the nucleus wil be masked by the magnetic effect of its motion in just the same way as for the electron, but for a neutron the conditions may be different. In the case of a neutron its magnetic moment is perhaps due only to its intrinsic spin moment, because the orbital magnetic moment may be negligible owing to the fact that the neutron is a particle carrying no net charge. The resultant spin quantum number of the theoretical normal term of the neutron arranged just like the extra-nuclear electrons is here coupled with the proton spin for obtaining the nuclear spin moment Since the nucleus of cæsium may be considered to be made up of 27 α-particles, 24 neutrons and 1 proton, the arrangement in shells of the 24 neutrons on the electronic model would give a normal term $3d^5 4s^1\ ^7S$ corresponding to a spin value of 3. Combining this vectorially with a proton spin of $\frac{1}{2}$ the minimum energy configuration would give a spin moment of $\frac{5}{2}$ for the nucleus of the cæsium atom. This theoretical result is in conformity with our experimental value

The Vertebral Column of Some South Indian Frogs.

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DR. H. K. MOOKERJEE has recorded in a note published in *Current Science* (Vol. I, No. 6, 1932), a case of *Rhacophorus maximus* in which the 8th. and 9th. vertebræ are procœlous, a condition which marks a departure from the well-known amphicœlous nature of the 8th. and 9th. having a boss in front and two behind such as occur in *Rana* generally. If it could be shown that the vertebræ are uniformly procœlous in this genus *Rhacophorus*, then its inclusion under the family Ranidæ, becomes a questionable procedure, since Nicholls has pointed out that the procœlous nature of the 8th. vertebra of *Bufo* may be used for diagnostic purposes. In view of the importance of the subject in its bearing on taxonomy I have examined the vertebral column of the following species:

Rhacophorus maculatus; Rh. eques; Rh. dubius; Rh. microtympanum; Ixalus chalazodes; I. sylvaticus; I. nasutus; I. oxyrhynchus; I. sp. (marked B in the museum collection); Micrixalus saxicola; Micrixalus sp. (marked A in the museum collection); Nyctibatrachus major; N. pygmœus; N. sanctipalustris; Nannobatrachus kempholensis (n. sp. Rao); Rana beddomii R. bhagmandalensis; R. breviceps; R. brevipalmata; R. crassa; R. cyanophlyctis R. curtipes; R. diplostichus; R. gracilis R. intermedius; R. leithi; R. leptodactyla R. limnocharis; R. malabarica; R. pantherina; R. parambiculamana (n. sp. Rao R. sauriceps (n. sp. Rao); R. semipalmata R. tennuilingua (n sp. Rao).

Of the four species of Rhacophorus examined by me, I notice that the centrum of the 8th. vertebra is a variable structure It is procœlous only in certain species such as *Rhacophorus maximus* (as reported by Mookerjee), *Rhacophorus dubius*, and *Rhacophorus microtympanum*, while it is amphicœlous in *Rhacophorus maculatus* and *Rhacophorus eques*. Possibly an examination of other species of this genus may reveal similar divergence and if it be so, then we have clearly included in this genus *Rhacophorus*, two groups which, so far as the character of the 8th. and 9th. vertebræ

concerned, will have to be dissociated. Whatever may be the nature of these vertebræ the transverse process of the 9th. vertebra is typically Ranid in the forms examined by me, and this fact should not be lost sight of in the investigation of the other species of *Rhacophorus*.

Prof. C. R. Narayan Rao informs me that the separation of *Micrixalus* from *Ixalus* is based on arbitrary grounds and possibly when a large number of species is examined, the diagnostic characters of the two genera may be found to be too slender for erecting two genera for their reception. Dealing, however, with the 8th. and 9th. vertebræ of these genera, I find that the former is procœlous in *Ixalus nasutus* (see Fig. 1),

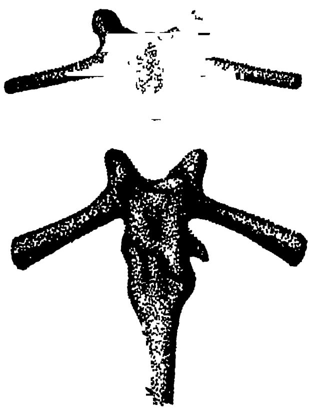

Fig. 1.

The procœlous 8th. and the fused 9th. and 10th. vertebræ of *Ixalus nasutus*.

Note the transverse process of the 10th. persisting on the left side and it has disappeared from the right. Additional proof is afforded of the fusion by the normal attachment of the urostyle on the right, while it is attached to the 10th. on the left side.

Ixalus chalazodes, *Ixalus sylvaticus* and *Ixalus oxyrhynchus*, while in species marked B in our museum collection it is definitely amphicœlous. In *Micrixalus* it is procœlous. There is divergence therefore in the character of the 8th. vertebra of *Ixalus*, some conforming to the Ranid group, others to the *Rhacophorus maximus* group, while *Micrixalus* is Ranid in every respect.

All the three species of *Nyctibatrachus* conform to the Ranid group in regard to the 8th. and 9th. vertebræ, while *Nonnobatrachus* bears procœlous 8th. and 9th. vertebræ.

Of the species of Rana only *Rana curtipes* and *Rana tennuilingua* call for special and critical observations, the others conforming to the normal feature.

Rana curtipes is indigenous to South India and is known for the large size of the tadpoles. A large number of these frogs were examined and the skeletons of adults were made for a comparative study.

In all the forms it is noticed that the 8th. and 9th. vertebræ are fused together to form a synsacrum. Dorsally the synsacrum carries a single moderately long neural spine. The zygapophyses are only two pairs and are borne on the anterior part of the fused 8th. and 9th. vertebræ (see Fig. 2). The transverse process in the region of the 8th. vertebra is similar to what is seen in the Ranid

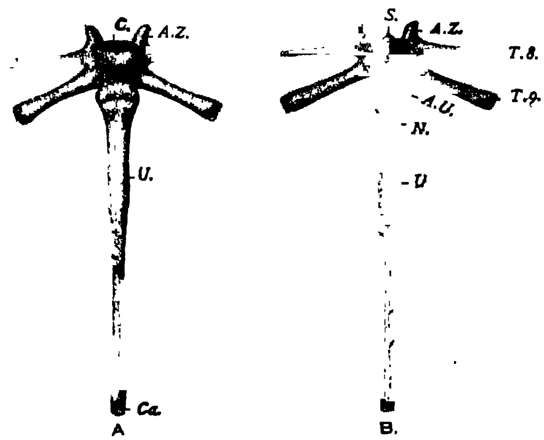

Fig. 2.

The fused 8th. and 9th. vertebræ and the Urostyle of normal *Rana curtipes*.

A. Ventral View. B. Dorsal View.

A.U. Articulation of the last vertebra with the urostyle; *A.Z.* Anterior zygapophysis; *C.* Procœlous centrum; *Ca.* Cartilage; *N.* Bony nodule on the urostyle; *S.* Neural spine; *T.* 8. Transverse process of the 8th. vertebra; *T.* 9. Transverse process of the 9th. vertebra; *U.* Urostyle.

examples. The transverse process in the region of the 9th. vertebra is large and expanded and bears epiphysis for the attachment of the ilium. The urostyle which is long, leaves a gap dorsally between the last vertebra and the commencement of the urostyle and at this point it bears a round bony nodule. At the terminal part, it is cartilaginous and in one case slightly anterior to the terminus, it shows an apparently segmented nature. In the same example of *Rana curtipes* (see Fig. 3) on the right side of the animal the transverse

process in the region of the 8th. vertebra expands itself and gives attachment to the ilium, while on the left side of the animal

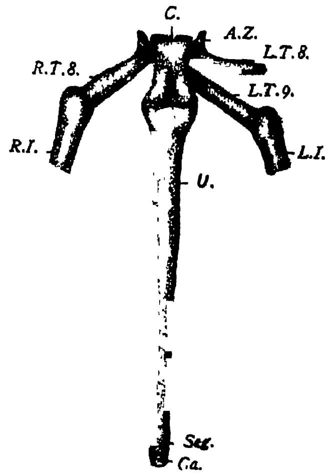

Fig. 3.

The fused 8th. and 9th. vertebræ and the Urostyle of *Rana curtipes*. Ventral View.

A.Z. Anterior zygapophysis; *C.* Procœlous centrum; *Ca.* Cartilage; *L.I.* Left Ilium; *L.T.* 8. Left transverse process of the 8th. vertebra; *L.T.* 9. Left transverse process of the 9th. vertebra; *R.I.* Right Ilium; *R.T.* 8. Right transverse process of the 8th. vertebra; *Seg.* Apparent segmentation; *U.* Urostyle.

there is a slender transverse process similar to what is seen in other examples of *Rana curtipes*. Further on the left side there is a typical transverse process belonging to the region of the 9th. vertebra (which is, however, absent from the right side) and this gives attachment to the ilium on this side.

One more variation is noticed; the transverse processes of the 3rd. vertebra bear an anteriorly directed bony process, a feature common in *R. tigrina*.

We may sum up the observations as follows: The possession of eight vertebræ (the fused 8th. and 9th. representing only one); the disappearance of the transverse process of the 9th. in one example on the right side and the shifting forward of the iliosacral attachment on this side by one segment, and the long urostyle possessing a bony nodule dorsally, are all points of great morphological interest. We may now discuss their significance.

In order to estimate the importance of the variation noticed in *Rana curtipes*, we have to recall the condition in *Pelobates*, *Pipa* and *Hymenochirus*. In these examples and in *Bombinator* the urostyle is fused with the last sacral vertebræ. *Pelobates* represents the oldest morphological condition in having 10th. and 9th. as the sacrum: in *Rana* and other forms the iliosacral articulation has been carried forward to the 9th., and in Pipa, the 9th. and 8th. participate in the attachment, their transverse processes fusing to form a broad winglike expansion to provide articulation with the ilia. Now, in the case of *Rana curtipes*, the centra of the 8th. and 9th. have fused, but their diapophyses remain discrete, those of the 9th giving attachment to ilia usually. In one case, the ilium on the right side of the animal is attached to the transverse process of the 8th.; the transverse process of the 9th. on this has atrophied, while on the left side the attachment is as in other cases of *Rana curtipes*. In the fossil forms of *Palæobatrachus* the 7th. is in a transitional state; while in *Hymenochirus* the first sacral vertebra is 6th. and those behind being added to the urostyle. The shifting forward of iliac attachment in these examples has been used to explain how the wide gap that separates the Urodeles from Anura in regard to the number of presacral vertebræ, can be bridged over. The position of *Rana curtipes* in the series is obviously one older than that of Pipa. In the former the centra of the 9th. and 8th. vertebræ have fused, but not their transverse process. which have also fused in the latter. In the example of *Rana curtipes* in which the lop-sided variation has been noticed, we have a condition perhaps more recent, the 9th having lost the transverse process on the right side. Thus Pipa stands between the normal *Rana curtipes* and the variant of this species.

In the next example,—*Rana tennuilingua* there are 9 vertebræ. The 7th. is amphicœlous, the 8th. opisthocœlous and the 9th. is typically Ranid. This is possibly an erratic variation since other examples of the same species do not show this phenomenon. As far as is known to me this is the first case to be recorded of the occurrence of the opisthocœlous nature of the vertebra among fermisternia, while a large number of cases could be cited among the arcifera. Judging by the inconstancy and the arbitrary nature of the centra in these forms, I think that the character of such variable structures as the vertebra may

not prove a very useful criterion in the classification of these forms.

In view of the extremely variable character of the 8th. and 9th. vertebræ in the Ranidæ, the generalisation of Boulenger that in those forms where the vertebræ are procœlous the 8th. is biconcave, seems to call for slight amendment, so as to permit the inclusion in it of the variation even within the limits of a genus. Obviously, these variations at least in the examples examined by me would appear to be fortuitous and can have no genetic significance.

In a further communication, I hope to be able to record the evidence derived from a study of the tadpoles of *Rana curtipes* bearing on the peculiarities of the vertebræ of this species noted in the present paper.

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Letters to the Editor.

The Wavestatistical Theory of Spinning Electron.

THE quantum mechanical theories of the spinning electron have been given by Dirac, Darwin and Pauli. Except that of the last one which is simple but not rigorous, the theories are based on non-commutative laws justifying the breaking up of a second order differential equation into the linear form. But in that case the dynamical aspect of the problem undoubtedly falls to the background. This point has been criticised at length in a recent paper of ours. (*Ind. Phys. Math. Jour.*, **3**, 65, 1932.)

We are now in a position to announce that even without introducing the idea of non-commutative association and consequent splitting of the second order differential equation, it is possible to derive Sommerfeld's correct expression for fine-structure. It may be briefly explained below:—

The well-known R-equation for the x_1 and x_2 waves in the $\{\mu\}$-space (for elliptic orbit) is:

$$\frac{d^2R}{d\gamma^2} + \frac{2}{\gamma}\cdot\frac{dR}{d\gamma} + \left(A + \frac{2B}{\gamma} + \frac{C}{\gamma^2}\right) R = 0$$

where $C = l\ (l+1)$, l having the values 0, 1, 2,....etc. It is well known that in case of electron-spin, the orbital moment always determines the sign of the total moment. Thus when $J = l + \frac{1}{2}$, l can have minimum value 0, but for $J = l - \frac{1}{2}$, l has the minimum value one. The dynamical basis of this may be seen without difficulty.

Now, as in the above R-equation $l_{min} = 0$, it may be used only for the +vely spinning electron. But for the −vely spinning electron C must be changed to $(l-1)\,l$; so that $l_{min} = 1$. Thus we have different R-equations for the +vely and the −vely spinning electron, which give in the usual way.

$$\frac{B}{\sqrt{-A}} = n\psi + l + 1, \quad \text{for +ve spin}$$

$$\frac{B}{\sqrt{-A}} = n\psi + L, \quad \text{for −ve spin}$$

Remembering the difference in the minimum values of l, we find that the Eigen-value of energy given by both is the same.

In the case of relativistic Kepler orbit the R-equation is unaltered in form but the constants A, B, C have the values (*vide* Sommerfeld-Erganzungsband)

$$A = \frac{4\pi^2}{h^2c^2}\ (E^2 - E_0{}^2), \quad B = \frac{4\pi^2}{h^2c^2}\ zc^2E \quad \text{and}$$

$$C = -l\ (l+1) + a^2z^2$$

As already pointed out C can have the above value for positive spin only. For negative spin

$$C = -l\ (l-1) + a^2z^2$$

It may be seen by following the usual method that neither of the two R-equations (with the two above values of C) give the correct Eigen-value of energy. This we find to be due to neglecting the effect of spin on the velocity of the x_1 and x_2 waves. It may be easily evaluated from the well-known Thomas effect (*Phil. Mag.*, **3**, 1, 1927) and is found to be of the same order as the relativity effect. We find that the values of A and B are unchanged but C has the value

$$C = -l\ (l+1) + a^2z^2 - \frac{a^2z^2}{2\,(l+1)}, \quad \text{for + spin}$$

$$C = -l\ (l-1) + a^2z^2 - \frac{a^2z^2}{2l}, \quad \text{for − spin}$$

Using these two corrected values of C in the R-equation we get

$$W = -\frac{Rhz^2}{n^2}\left\{1+\frac{\alpha^2 z^2}{n^2}\left(\frac{n}{l+1}-\frac{3}{4}\right)\right\}, \text{ for } + \text{ spin}$$

$$= -\frac{Rhz^2}{n^2}\left\{1+\frac{\alpha^2 z^2}{n^2}\left(\frac{n}{l}-\frac{3}{4}\right)\right\}, \text{ for } - \text{ spin}$$

which are the well-known spin-relativity Eigen-values of energy.

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Polyembryony in Solanaceæ.

HABERLANDT[1] has observed parthenogenetic development of the endosperm, and early stages in the development of adventitious embryos in *Scopolia*, grown under unfavourable conditions. Biraghi[2] also observed the formation of adventitious embryos in *Nicotiana rustica* var. *Brasilia*, when pollinated with *Petunia* pollen. Young[3] found the presence of more than one embryo-sac in the same ovule of *Solanum tuberosum*. He believes that only one embryo-sac matures while the other degenerates. In the course of our investigation on the embryology of Solanaceæ, evidence of polyembryony has been obtained in different genera grown under natural conditions. In *Nicotiana plumbaginifolia* two well-developed embryos have been found in two separate embryo-sacs in the same ovule (Fig. 1). Two fully mature embryo-sacs in the same ovule have also been observed in *Withania somnifera* (Fig. 2), and in *Physalis minima*. Earlier stages in the development of adventitous

Fig. 1.

Nicotiana plumbaginifolia; two developed embryos in the same ovule.

Fig. 2.

Withania somnifera; two mature embryo-sacs in the same ovule.

embryos by the budding of the nucellar cells covering the embryo-sac have been observed in *Petunia nyctaginiflora* and in *Withania somnifera*. It follows, therefore, that polyembryony is not uncommon in Solanaceæ. The development of more than one embryo-sac in the same ovule is generally due to the simultaneous development of more than one megaspore mother cell, which appears to be a common feature in most of the species of Solanaceæ. A detailed study of

[1] Haberlandt, "Schnarf", *Vergleichende Embryologie der Angiospermen*, p. 177, 1931.

[2] Biraghi, *Annali di Bot.*, **18**, 216, 1929.

[3] Young, *Amer. Jour. Bot.*, **9**, 213, 1922.

the embryogeny of Solanaceæ has been made by the junior author and will shortly appear elsewhere.

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The Germ Cells of *Ichthyophis glutinosus*.

PROBABLY due to difficulty in getting adequate material, our knowledge about the germ cells in Gymnophiona, their origin and the general problem of gametogenesis in this group remains very meagre as compared with the work on other amphibians. Apart from the works of Spengel[1] and the Sarasins[2] no reference to any recent literature is available. Even these authors confine themselves to certain aspects of the urino-genital system of Gymnophiona. The Sarasins have described the mature spermatozoan and admit to their not having studied its development.

The testes in Ichthyophis are segmented and extend over nearly two-thirds of the length of the body. One fact of importance is the indefiniteness in the number of these testis-lobes, which may vary in different animals and even on the two sides of the same individual. The latter feature may perhaps be explained as due to the asymmetry of organs on the two sides consequent on the burrowing and coiling habit of these animals. So far as I am aware, the number of the testis-lobes may vary between six and fifteen on each side. Nor is there any relation between the number of the testis-lobes and the age of the animal. For, I have found in young forms (where still the gill clefts are not closed) the number of the testis-lobes larger than in some adults. The size of the lobes also is subject to great variation. Sometimes a lobe may measure over 5 mm. in length in certain regions while in others, it may be smaller than a millimetre.

Fig. 1.

Longitudinal section of a testis-lobe of Ichthyophis.

The anatomy of the testis and its relation with the excretory system have been studied by Brauer.[3] An external examination of the testis-lobe reveals its deeply lobulated nature, marked on the surface by convex rounded elevations. In Urodeles (Humphrey,[4] Kingsbury[5]) the testis is an elongated cylindrical organ traversed by a longitudinal central collecting duct around which the lobules are arranged radially. It is also well known that in each locule, the cells develop synchronously. In some forms (Kingsbury,[5] Humphrey[6]) a postero-anterior development of the germ cells (Spermatogenetic wave) has resulted in the formation of a multiple testis, which, however, is different from that in Ichthyophis. In this form, the longitudinal collecting tube is by no means so regularly central as in Urodela and the locules are arranged in a more irregular fashion. Another thing of importance is the absence of this synchronous development of the germ cells in the locules. The locules are very large and filled with loose fibrous tissue in which are embedded the germ cell cysts without any definite walls of their own. A large number of such cysts can be distinguished in each locule representing every stage in spermatogenesis, from the spermatogonia to the fully formed sperms.

The testis is covered by a germinal epithelium which is continuous with the peritoneum of the coelom. It is usually thin consisting of a single layer of columnar or cubical cells but at some places thickens to form aggregations of very deeply staining cells. An examination of the sections of the testis shows that these aggregations occupy the interstices of the locules also, investing

[1] Spengel, J. W., 1876. *Arb. aus dem Zool. Zootom*, 3, S. 1–114.

[2] Sarasin, P. & F., 1890. *Ergeb. Natur. Furchungen auf Ceylon*, 2, S. 1–263.

[3] Brauer, 1902. *Zool. Jahrb. (Anat.)*, XVI.

[4] Humphrey, R. R., 1925. *Biol. Bull.*, Vol. XLVIII, No. 3, pp. 145–166.

[5] Kingsbury, B. F., 1902. *Am. Journ. Anat.*, Vol. I.

[6] Humphrey, R. R., 1922. *Biol. Bull.*, Vol. XLIII.

the collecting ducts. Hargitt[7] has shown that in Diemyctylus, the lining of the ducts gives rise to the germinal epithelium from which fresh spermatogonia arise in the adult. He figures the terminal branches of the ducts

Fig. 2.

A part of the longitudinal section of a testis-lobe of Ichthyophis showing one of the locules emptying its contents into a duct. The darkly staining cell aggregations represent the source of the germ cells in the adult.

D —Duct. *G.C.ag.*—Germ cell aggregations.

ending blindly in masses of germ cells. In Amphiuma, MacGregor[8] finds the central duct of the testis capable of sending spermatogonia into the locules which are arranged in a radial manner around it. In Ichthyophis, it is not only the terminal branches of the ducts that give rise to the germ cells, but throughout its extent in the testis, the duct system is capable of developing germ cells from its lining. The similarity of the cells in the germinal epithelium on the surface of the testis and in these internal aggregations is very striking and there are reasons to believe that in both cases these cells first migrate into the locule and are later transformed into spermatogonia. Occasionally, however, mitoses may occur in these germinal cells.

A study of the spermatogenesis of this animal is in progress and the results will be published elsewhere.

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[7] Hargitt, G. T., 1924. *Journ. Morph.*, Vol. XXXIX, No. 1.

[8] MacGregor, H., 1899. *Journ. Morph.*, Vol. XV, Suppl.

Spectrum of Bi III.

THE spectrum of Bi III has been analysed by Lang[1] and Mclennan[2], Mclay and Crawford. The classification of the higher transitions is identical in the two cases but of the fundamental transitions it is different. Mclennan, however, did not find $6p\ {}^2P_1$, the deepest term of the spectrum. Of the multiplet $6p\ {}^2P - 6d\ {}^2D$ of Lang the line 75924(30) belongs to Bi IV as shown by Arvidsson[3] and 74065(15) has not been obtained by Arvidsson nor is it present in the work of Lang.[4] Line 70257(10) of $6p\ {}^2P - 7s\ {}^2S$ fits well from considerations of intensity and position in the spectrum of Bi II[2] as $6p^2\ {}^1D_2 - 6p\ 6d\ {}^1F_3$, 87169(4) taken from Arvidsson's list, being $6p^2\ {}^3P_2 - 6p\ 6d\ {}^1F_3$. 101023(12) in $6p\ {}^2P - b\ {}^2S$ belongs to Bi IV[3]. The intensities of the pair $6p\ {}^2P_{1\text{-}2} - b\ {}^2D_2$ are unexpected and the pair may be fortuitous.

Extrapolating from the spectrum of Tl I and Pb II the separation of $6p\ {}^2P$ for Bi III should be about 20500. The following pairs with a frequency difference of 20790 have been obtained:—

95074(8)	96154(4)	108052(6)	108586(7)	130966(2)
74287(15)	75367(9)	87266(6)	87795(4)	110176(5)

In the first two pairs, the lines 74287 and 75367 have been already identified by the above authors as $6p\ {}^2P_2 - 7s\ {}^2S$ and $6p\ {}^2P_2 - 6d\ {}^2D_2$. 95074 and 96154 may be fixed as $6p_1\ {}^2P_1 - 7s\ {}^2S_1$ and $6p\ {}^2P_1 - 6d\ {}^1D_2$. The other pairs probably arise from $6p\ {}^2P - 6s\ 6p^2\ {}^{4,2}P.{}^2D.{}^2S$.

Due to some misprint the value of $6p\ {}^2P_2$ in Mclennan's paper is given 184390, 1000 less than the actual value. Making the correction $6p\ {}^2P_1$ is thus equal to 206180.

JAI KISHEN.

S. D. College, Lahore,
March 1933.

Measurement of Viscosity by Oscillating Columns.

THE method of oscillating columns was used for determining the viscosity co-efficients by Menneret[5] and Subrahmanyam[6], whose work both theoretical and experimental was

[1] Lang, *Phys. Rev.*, **32**, 737, 1928.

[2] Mclennan, Mclay and Crawford, *P.R.S.*, **129**, 579, 1930.

[3] Arvidsson, *Ann. Der. Physik*, **12**, 802, 1932.

[4] Lang, *Phil. Trans. Roy. Soc.*, **224**, 371, 1924.

[5] *J. Phys.*, **I**, 753, 1911.

[6] *Ind. Jour. Phys.*, **I**, 267, 1927.

found, on examination, incomplete and incapable of giving correct results. It can be shown mathematically that the logarithmic decrement for a liquid oscillating in a U tube to be $\frac{1}{2} \nu k^2 t$, where ν is the kinematic viscosity co-efficient and $k=1\cdot 2197 \pi/a$ where a is the radius of the tube. The oscillations can be photographed and the log. dec. measured. By applying the above formula values were obtained for ν, and they agree very well with the standard values given in International Critical tables. Full details of the work will appear elsewhere.

J. C. KAMESVARA RAV.
S. VENKATARAMAN.

Nizam College,
Hyderabad (Dn.),
March 25, 1933.

The Cathode Fall of Potential in Arcs.

LANGMUIR[1] has shown how it is possible to obtain a reliable estimate of the space potential and electron concentration by a study of the volt-ampere characteristics of a probe collector immersed in an ionised gas. This method has been employed by a number of experimenters to determine the cathode fall in arc discharges. Measurements have been made in the case of mercury by Lamar and Compton[2] and in the case of cadmium and thallium by Nottingham[3] and it was found by these observers that the cathode fall in each case was in the neighbourhood of the ionisation potential of the respective metals. Similar measurements have been made in a copper arc by Nottingham[4] and it is found that the cathode fall is 20·5 volts while the first ionisation potential of Cu is only 7·69 volts. It is interesting to note also that Anderson and Kretchman[5] who measured the cathode fall in a tungsten arc found it to be 16·2 volts, while the total potential across the arc itself was only 14 volts with a current strength of 12 amperes.

Measurements of a similar kind are comparatively difficult in the case of the sodium arc and the first attempt to determine the cathode fall in sodium was made by the present writer[6]. In the type of arc used by the author, the cathode was a pool of sodium with a device for restricting the movement of the cathode spot and the anode was an iron rod cooled by a stream of oil circulating through it. The cathode fall of potential was found to be 6·2 volts, the current strength in the experiments being 2 amperes. The cathode fall was found to rise up to 7·5 volts when a tungsten wire anode was used in place of the cooled iron anode. Recently F. H. Newman[7] describes a similar set of measurements he has carried out in a sodium arc carrying 5 amps. current and has found the cathode fall to lie close to 5 volts, the ionisation potential of sodium being 5·12 volts.

It is to be noted that the experimental results for the cathode fall in several metallic vapours as obtained by different observers do not show much agreement. For instance, in the case of mercury, Kömmnick and Lubcke[8] find the cathode fall lying between 9·0 and 11·3 volts in place of 10 volts as found by Lamar and Compton[9] and they point out that the cathode fall is influenced by pressure and density of the vapour. On the other hand, if the high field emission theory put forward by Langmuir[10] applies to the "cold cathode" discharge of the mercury arc type, the cathode fall for mercury shall have to exceed 13·4 volts as shown by R. C. Mason[11] from theoretical considerations based upon quantum mechanics. The discrepancy between the results obtained by the different observers and the discrepancy between the experimental and theoretical values in the case of mercury, indicate that the cathode fall is probably influenced to a marked extent by the conditions of the arc, such as current density and vapour pressure. Quite recently J. Kömmnick[12] finds that the cathode fall of potential in the mercury arc increases with decrease of the vapour pressure. This observation seems to account, therefore, for the difference in the value of 6·2 volts for the cathode fall in the sodium arc for a current strength of 2 amperes obtained by me and the value of 5 volts, corresponding to a current of 5 amperes

1 *Gen. Elect. Rev.*, 440, 1924.
2 *Phy. Rev.*, **37**, 1069, 1931.
3 *Jour. Frank. Inst.*, **206**, 43, 1928.
4 *Jour. Frank. Inst.*, **207**, 299, 1929.
5 *Phy. Rev.*, **26**, 23, 1929.
6 *Proc. Ind. Sci. Congress*, p. 106, 1932
7 *Phil. Mag.*, **15**, 601, 1933.
8 *Phy. Zeit.*, **33**, 215, 1932.
9 *Loc. cit.*
10 *G. E. Rev.*, **26**, 731, 1923.
11 *Phy. Rev.*, **38**, 427, 1931.
12 *Ann. der. Physik.*, **153**, 273, 1932.

observed by Newman,[13] since the vapour pressure is directly influenced by current density. It is also interesting to note, according to the observations of F. H. Newman,[14] that the fall of potential across the sodium arc decreases from 16 volts to 10·5 volts for an increase of arc current from 3·2 to 6·8 volts.

As regards the reliability of the measurements by Langmuir's probe collector method, F. H. Mohler[15] records that the probe wire measurements in his investigation of probabilities of recombination in the $6^2S_{\frac{1}{2}}$ state of caesium gave correctly the electron velocity distribution. J. Johannesson[16] who has devised a new probe method finds good agreement for the values of space potential obtained by his and Langmuir's collector method in a discharge tube. It therefore looks that a more extensive set of data of the cathode fall as influenced by varying arc conditions are needed before Langmuir's high field emission theory can be considered conclusively to apply to cold cathode arc discharges.

C. K. SUNDARACHAR.

Central College,
Bangalore,
April 5, 1933.

Spectrum of doubly ionised Cerium.

THE spectrum of doubly ionised cerium between λλ 3600 to 2100 consists of triplets and singlets and is similar to singly ionised lanthanum in many respects. Practically all the lines which have so far been unambiguously identified as due to Ce^{++} are derived from transitions between the terms of the configurations 4f 5d, 4f 6s, 4f 6p, and 4f 6d. The strongest combinations are between 4f (6s—6p). Some of these terms are given below:—

4f 5d

1.	0	9.	5118·7
2.	797·9	10.	5372·1
3.	1648·0	11.	6327·9
4.	2334·6	12.	6998·2
5.	3823·4	13.	7139·0
6.	3982·9	14.	7678·4
7.	4397·9	15.	10134·8
8.	4624·2	16.	10649·4

4f 6s

1.	13732·6	3.	15973·0
2.	13968·8	4.	16345·9

4f 6p

1.	42763·8	7.	46137·1
2.	42901·6	8.	46678·2
3.	44554·6	9.	46937·6
4.	44871·7	10.	48112·5
5.	45758·6	11.	49045·9
6.	45786·1	12.	49053·0

Complete list of the classified lines alon with the identifications of the terms will b published elsewhere.

PRAN NATH KALIA

Department of Physics,
Government College,
Lahore,
February 12, 1933.

Viscosity of Liquids.

THE letter of Prof. Andrade in *Natu* (March 1 and April 12, 1930) on the variatio of the viscosity of liquids with temperatu on the conception of "a transitory an fluctuating crystallisation" occurring in tl body of the liquid has created a good de of interest in the subject, and the publica tion of his full theoretical discussion eagerly awaited. Historically his formul connecting viscosity with temperature ma be traced back to Porter's original relatio ship $\log \phi = m \log p + c$ (*Phil. Mag.*, 2 page 458, 1912) where ϕ is inverse of η th viscosity, p is the vapour pressure an m and c are constants. This when combin ed with the Clausius-Clapeyron equatio $\log p = -Q/RT + C$, where Q is the heat c evaporation and R and C are constant gives the formula $\log \eta = A + \frac{B}{T}$ which the formula put forward by Andrade.

The same formula had also been pu forward by Sir C. V. Raman in *Natu* (April 12 and May 5, 1923) on the assumptio that the liquid state is composite in charac ter, being composed in part of molecule rigidly attached to each other somewhat a in a crystal and may be termed "crystal line" molecules and in part of molecule which are relatively free and mobile a in the gaseous state and may be terme "vapour" molecules. Raman not onl outlined there a physical mechanism of th phenomena of liquid-viscosity but pointe out also the theoretical significance of th constants occurring in the above formul

[13] *Loc. cit.*
[14] *Phil. Mag.*, **14**, 712, 1932.
[15] *B.S.J.*, **6**, 277, 1931.
[16] *Ann. der Phy.*, **13**, 953, 1932.

The formula seems to be of very wide application and has been tested in case of 87 liquids by M. P. Venkataram Iyer (*Indian Jour. of Physics*, **5**, p. 371, 1930) and also by B. Prasad (Unpublished work) who finds good agreement between the observed and the calculated values except in case of water and some higher alcohols. But all these are highly associated liquids for which Andrade has suggested the formula $\eta = A' e^{\frac{B'}{T-\theta}}$ and with this the agreement is quite satisfactory. The formula has also been tested in case of solutions and the results have been communicated elsewhere for publication. Attempts are also being made to extend the applicability of the formula to liquids of no definite chemical composition and mixtures.

It is interesting to note in this connection that in his letter to *Nature* (April 12, 1930) Black had pointed out that Andrade's formula does not hold so well in case of certain mineral oils as does the formula of Slotte. Andrade had disposed of Black's objection on the ground that the mineral oils were of no definite chemical composition. But, if instead of using Andrade's original formula for simple liquids we use the formula $\log \eta = A + \frac{B}{T-\theta}$ for associated liquids the agreement in case of Black's oils is found to be better than that with Slotte's formula, as will be seen from the table given below. The value of the constants used in the formula are as follows :—

$A = -3 \cdot 2878,\ B = 548 \cdot 78,\ \theta = 170 \cdot 22$

Temp. C.	η(obsd)	η_{cal}(Slotte)	η_{cal}(Mine)
20	15·20	15·46	15·21
25	10·15	10·19	10·17
30	7·04	6·99	7·01
35	4·97	4·93	4·95
40	3·58	3·58	3·59
45	2·67	2·66	2·67
50	2·00	2·01	2·01
55	1·55	1·558	1·55
60	1·232	1·217	1·217
65	0·965	0·966	0·963
70	0 780	0·777	0·775
75	0·633	0·636	0·630
80	0·517	0·522	0·518
85	0·432	0·435	0·432
90	0·362	0·363	0·362
95	0·306	0·305	0·306

In view of the agreement found in case of the mineral oils measurements are being undertaken with some vegetable oils, oil-mixtures and lubricants to find out how far the formula agrees in their case too.

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Magnetism.

UNDER the auspices of the Mathematics and Physics Section of the 20th Indian Science Congress, a Symposium on Magnetism was held during the Congress Week at Patna. DR. A. L. NARAYAN who presided, inaugurating the symposium, said : "The subject of to-day's discussion is one which is of great importance in modern physics and is now engaging the attention of quite a number of investigators. Recent years have witnessed an extensive development both in theory and experiment. The application of the new quantum mechanics has removed a number of difficulties that confronted the explanation of magnetic susceptibilities of the ions of the iron group. A large part of this success is due to Professor Van Vleck who has also recently published a standard work on the subject. It is fortunate that a discussion on this interesting and important branch of Physics will be opened by Professor D. M. Bose whose own researches showed the direction in which lay the solution of the difficulties that beset an explanation of the paramagnetism of the rare earth ions. The work of Stoner and Van Vleck has proved the justice of the position taken by Professor Bose and given a theoretical basis for his views.

The study of the magnetic birefringence in liquids discovered by Cotton and Mouton has thrown much light on molecular anisotropy. Sir C. V. Raman, I. Ramakrishna Rao and K. S. Krishnan have carried out a number of important investigations in this field. Mr. Krishnan is now engaged at Dacca in new researches on magne-crystalline phenomena and we await with interest his exposition of the subject. At Calcutta Mr. Chinchelkar is continuing Ramakrishna Rao's researches on optical anisotropy and he will favour us with a resume of the work done in this field. I may mention some other Indian investigators who are working in this field : Dr. Vaidyanathan at Calcutta, Professor Bhatnagar at Lahore, Dr. S. Ramachandra Rao at Annamalainagar and Messrs. L. Sibaiya and H. S. Venkataramiah at Bangalore are engaged in the study of magnetic susceptibilities and have obtained interesting results. The work of Mr. S. Paramasivan on the difference in the susceptibilities of graphite in the solid and powdered states deserves mention in this connection.

Professor B. Venkatesachar is to speak on a subject which is as yet undeveloped, but promises to be of great interest, *viz.*, the magnetism of the

nucleus. Ever since Pauli showed that the hyperfine structure of spectral lines could be explained by assuming a mechanical and magnetic moment for the nucleus, and the classical work of Back and Goudsmidt completely vindicated this idea, a large number of workers have engaged themselves in the study of hyperfine structure and nuclear moments. Work in this field is being carried out by me and my collaborators at Kodaikanal and some of our results have already been published. The results recently obtained by A. S. Rao in his investigation of the H.F.S. of Tl, As and Br deserve special mention. A theoretical explanation attempted by Goudsmidt, Cassimir, Fermi, Breit, Racah and others has only served to show the inadequacy of the theory, and among other anomalies, unexplained and faint, but real, satellites have been found by Professor Venkatesachar. One such anomaly is the erratic relations of the g (1) factors of the nuclei of different elements. Professor Venkatesachar here makes an interesting way of explaining this behaviour of atomic nuclei. He bases his contribution on the new possibilities opened up by the discovery of the neutron and the attempt of Heisenberg to explain the radioactive properties of nuclei by using the neutron hypothesis. It is a fascinating field although as yet isolated from the main current in the subject of magnetism. I now have much pleasure in calling upon Dr. Bose to open the discussion."

DR. D. M. BOSE opened the discussion with an account of the development of magnetic theory up to the present time. He referred to his own contribution to the subject and its bearing on its future history.

DR. K. S. KRISHNAN speaking on some magnocrystallic investigations said, "Measurements have been made in the author's laboratory on the magnetic anisotropies of a large number of crystals and the results are discussed in relation to crystal structure.

It is found that in the case of diamagnetic crystals, the crystalline anisotropy can be explained in terms of the intrinsic anisotropy of the individual molecules or ions constituting it, and their relative orientations in the crystal. Hence, when the molecular magnetic constants are known, a correlation of these constants with those of the crystal, gives us valuable information regarding the orientations of the molecules in the crystal lattice. In favourable cases like biphenyl, dibenzyl, α- and β-naphthols, etc., it is found possible, in this manner, to locate the precise molecular orientations. In less favourable cases some of the angular parameters defining the molecular orientations can be so derived. Even in complicated cases like azobenzene and stilbene, where it is not possible to obtain a unique solution, the magnetic data throw considerable light on the question, which would help us at least to decide between alternative orientations suggested by X-ray methods. In any case it is clear that no structure proposed by X-ray methods can be considered acceptable that cannot satisfactorily explain the observed magnetic properties of the crystal. Thus the magnetic method of analysis of molecular orientations in crystals promises to be a useful supplement to X-ray methods of analysis.

Conversely, when the molecular orientations in the crystal lattice are already known from X-ray investigations, a knowledge of the principal magnetic susceptibilities of a diamagnetic crystal enables us to deduce the constants for the molecules. The values for naphthalene and anthracene molecules thus calculated are of interest; it is found that as we proceed from benzene to naphthalene and from naphthalene to anthracene, the numerical increase in susceptibility is practically confined to one direction, *viz.*, that which is normal to the plane of the benzene rings.

Similar measurements have been made on a number of paramagnetic crystals. (A special method is developed for the measurement of very feeble anisotropies of the order of one-hundredth of one per cent.) The results are discussed on the basis of the recent theories of magnetic anisotropy proposed by Bethe, Van Vleck and others. Also the results of earlier measurements are critically examined, especially those of Jackson on $CoSO_4.(NH_4)_2SO_4.6H_2O$ and on $MnSO_4.(NH_4)_2SO_4.6H_2O$, and the wide discrepancies between the results obtained by different observers are explained.

Some measurements on the influence of the state of aggregation of diamagnetic molecules on their susceptibility are also reported."

MR. S. W. CHINCHELKAR speaking next said: "The longitudinal Faraday rotation of plane of polarisation has been known to be of two types, diamagnetic and paramagnetic. The researches in the paramagnetic type were mainly due to Beegusel and others, and its chief features are certain dissymmetries and under certain circumstances a negative sign. Ladenburg gave a theory of the paramagnetic Faraday effect and attributes it to paramagnetic orientation in a magnetic field. The transversal phenomenon of magnetic double refraction discovered by Cotton and Mouton in pure substances, was however, until recently, known to be exhibited by diamagnetic substances only. It is explained by Langvin's theory according to which the molecules of the fluid showing the effect tend to orientate when kept in a magnetic field on account of their magnetic anisotropy, and this tendency gives the medium a doubly refracting property due to the optical anisotropy of the molecules. A search made to find a corresponding phenomenon for paramagnetic substances has recently proved a success, and it has been shown at Calcutta that the aqueous solutions of salts of rare earths, which are paramagnetic, exhibit a magnetic birefringence. These solutions also show the paramagnetic Faraday effect, and a parallelism between the two phenomena in these solutions suggests that this new type of magnetic birefringence is an orientation phenomenon, although it is not clear whether Langvin's theory as it stands would be applicable here. The birefringence does not appear to show a simple relation with the magnetic moment of the ions. Gadolinium salts, though strongly paramagnetic, do not exhibit a magnetic birefringence in solution. The gadolinium ions are in the S state, having the whole of their paramagnetic due to spin, without any orbital contribution; and this shows that an orbital contribution to the magnetic moment is essential for the birefringence to be shown. Observations on the values of magnetic birefringence that have appeared recently, show very interesting regularities as we pass along the rare earth series. It is known that the series can be divided into two parts, one before and the other after gadolinium, corresponding to the erect and

inverted multiplets, and in each half the orbital contribution undergoes a similar variation. The magnetic birefringence is seen to be negative at the beginning of each half, then diminishes in magnitude and at the end of each half assumes a positive sign. The whole phenomenon is not yet quite clear, but promises to be of great interest and significance, and further experimental data are necessary."

PROF. B. VENKATESACHAR then spoke on 'The Magnetic Moment of the Nucleus.'*

In the discussion that followed, Dr. I. Ramakrishna Rao spoke as follows: "The small but finite optical anisotropy of the aliphatic compounds as revealed by the depolarisation of light scattered by them has led Prof. Raman and myself to examine if these molecules do not possess a corresponding magnetic anisotropy. Cotton and Mouton who discovered magnetic birefringence in the aromatic compounds, could not detect it in most of the aliphatics, which led them to conclude that the molecules of the latter class are magnetically isotropic. Thinking that this may be due to the feebleness of the phenomenon, we constructed a specially powerful electro-magnet. With the column of liquid perpendicular to the magnetic field, we found that there was a distinct double-refraction revealed by many of the aliphatic liquids when the magnetic field was on. There were two difficulties in the investigation of the phenomenon. The first was the elimination of the superimposed Faraday Effect which was accomplished after making the column of liquid exactly perpendicular to the magnetic field. The second was the measurement of the feeble double-refraction. While devising sensitive methods of measuring it, I had to leave Calcutta and Messrs. Ramanatham and Chinchelkar who continued the work and made quantitative estimates of the phenomenon ought to be congratulated upon the important work they did in this direction, thus making a distinct contribution to our knowledge of the magnetic anisotropy of the aliphatic molecules."

MR. L. SIBAIYA said: "The theories of diamagnetism developed by Van Vleck, Pauling and Hartree on the basis of the new quantum mechanics apply only to centro-symmetrical systems whose constituent particles can be regarded as independent. For such systems only, as Stoner points out, the diamagnetic susceptibility should not alter with temperature, since under those conditions the value depends on the configuration of the systems and not on their interaction. Even for Cl however the calculated susceptibility according to Hartree or Pauling is much too large. Experiments have shown that the diamagnetic susceptibility shows in some cases considerable variation with temperature, pointing to the conclusion that thermal agitation and molecular interaction play no negligible role. The variation in the case of water, for instance, is due to the increasing thermal agitation and to the progressive dissociation of such molecules as $(H_2O)_n$ at higher temperatures. Wills and Bocker, however, have very recently reported an anomalous behaviour for water.

Besides, from Pascal's measurements, the gram-molecular susceptibility of liquid benzene is -56×10^{-6} while from the results of Sone, Wills and Hector, and Vaidyanathan the susceptibility of benzene vapour is -83×10^{-6}. Though these data require further support, the diminution of mutual molecular influence in the vapour state has to account for the increased diamagnetism of benzene vapour. According to the orbital electron theory the mutual induction effect of the component systems must be more pronounced in the liquid state. Oxley also finds that there is a decrease of susceptibility of about 5% on passing from the liquid to the solid state. Thus it seems that the diamagnetic susceptibility decreases from vapour to liquid and further from liquid to solid states. This must correspond to the effect of reducing the temperature. To explain his observations Oxley assumed a molecular magnetic field of several million gauss which accounted also for the tensile strength of solids and the density change on solidification. On the other hand the diamagnetism of gallium, indium, thallium and bismuth decreases with increasing temperature. Again even a metal cannot be regarded as an aggregate of atoms with characteristics similar to those which they have in the free state. For instance the paramagnetic atoms, such as those of copper and silver, may form a diamagnetic solid. And the diamagnetism due to free electrons may be of the same order as that due to orbital electrons in metals.

Lastly, along with this dependence of susceptibility on the state of aggregation of the molecules, the mutual influence seems to be related also to the number of molecules at least upto a limit. The variation of susceptibilities of para- and diamagnetic colloids in relation to the particle size shown by Ramachandra Rao and by Montgomery supports this view. The intensities of magnetisation of colloid powders of nickel have been pointed out to be less than that of pure nickel; and the investigation with bismuth colloids has shown that the intensity of magnetisation decreases with particle size.

Thus the effects of temperature, state of aggregation and particle size on the susceptibility value should be first experimentally studied before a satisfactory theory of diamagnetism can be put forward.

* Prof. Venkatesachar's contribution has already appeared in these columns (*Cur. Sc.*, **1**, 8, 1933).

The Malers and the Malpaharias of the Rajmahal Hills.

By Sasanka Sarkar, M.SC., *Anthropological Laboratory, Indian Museum, Calcutta.*

THE Mālers of the Rajmahal Hills occupy the north-eastern portion of the district of the Santal Perganas. They live on the slopes of the hills and are still in a very primitive condition. The Mālpāhāriās, who belong to the same ethnic stock but live on the plain lands, are at present much Hinduised as a result of their intercourse with the neighbouring people. They occupy the southern portion of the Santal Perganas. In the course of my investigations among these tribes I discovered that the place (Pakur-Godda area) where these two cultures meet shows a curious intermixture of manners and customs.

The Mālers have no clans, no exogamous divisions. Marriage is controlled by kinship and there cannot be any marriage with anybody falling within the kindred groups. These people can trace their blood groups, however, only up to the third generation. In collecting genealogies I often failed to secure the name of the informant's own grandfather, and among the Mālpāhāriās in more than one instance I failed to secure their father's name even. Both the Mālers and the Mālpāhāriās have got a small patrilineal family which usually consist of their wives and children and in recent years a few joint families have sprung up among the latter, after the Hindus. The Mālpāhāriās, also, have adopted the clan system, although this is not universal among all the Mālpāhāriās. The clan system is not met with among the Mālpāhāriās of the Pakur-Godda area, where they are living as close neighbours of the Mālers. Here, I also discovered a few instances of intermarriages between the two groups. The Mālpāhāriās of Dumka only present the clan system and these have been taken mostly from the Hindu titles of castes. A few words also have been taken from the Māler language—the Mālto. The Mālpāhāriās are at present classed within the Bengali-speaking people. The following are the names of the eleven clans of the Mālpāhāriās that I was able to collect:—(1) Singh, (2) Kumār, (3) Ārhi, (4) Derhi, (5) Grihi, (6) Mānjhi, (7) Pujhor, (8) Rai, (9) Ghuns, (10) Pātor, (11) Daloi.

The Derhi and Pujhor function as priests; the Derhi functions in the aboriginal worships while the Pujhor in the Hindu ones. The occupational basis is practically non-existent but in one of the genealogie that I collected I found a man describin himself as belonging to three clans. H father was a Singh, so he is a Singh; he a Derhi and a Pujhor because he worshi both the tribal and the Hindu deities.

Marriage among the Mālpāhāriās permitted both inside and outside the abo clans. Their clans very rarely play a important part in the choice of mat although I have always found them cogn sant of the exogamy of the Santal an Hindu clans. As among the Mālers, t Mālpāhāriās control their marriage accordin to the prohibited degrees of relationship The prohibited relations include the patern uncle, maternal uncle, paternal aunt an maternal aunt and their children.

A study of the kinship system of the tw tribes reveals some features of dual organiz tion. The classificatory system is fairl widespread. There is a great deal of diffe ence in the kinship terms of the two peop —the Mālers retain Mālto words, where the other has Bengali terms, but there a traits of similarity in the kinship system a whole among both. Evidence for du organization may be seen in the use of th same terms for father's elder brother an mother's elder sister's husband (Pipo) an their wives (Peni); and father's young brother and mother's younger sister's hu band (Dādā) and their wives (Kāle) amon the Mālers. Among the Mālpāhāriās w find it true of only the above first pair relatives although the terms Jethā (father elder brother) and Jethi (father's eld brother's wife) are both borrowed fro Bengali; the father's younger brother an his wife are called Kākā and Kāki, respe tively, and the mother's younger sister an her husband Moshi and Moshā, respectivel The differentiation between the elder an younger brother of sister of either paren seems to be a recent one among the Māler probably due to their contact with t Bengalis. It appears that the Mālers an and the Mālpāhāriās belong to the sam race and culture although at first sight the seem to be widely disconnected.

[1] Risley, H. H., "The Tribes and Castes Bengal," Calcutta, 1891, Vol. 1, Introductio p. xlix.

A Marine Biological Station for India.

THE desirability of establishing a Marine Biological Station in India was emphasised at a joint session of the Botany and Zoology sections of the Indian Science Congress recently held at Patna under the Presidentship of PROF. GOPALA AIYER. A large number of speakers took part in the discussion.

COL. SEWELL, in opening the discussion, referred to the great gap which would be filled by the establishment of such a station. Huge sums of money were spent annually on the expansion of agricultural schemes while the sea which provided sustenance to a considerable number of people in the country was yet left entirely untapped. He sounded a note of caution and observed that in setting up such a station, people ought not to be swayed by economic constitutions alone which were only secondary and subservient to the primary scientific and educational aspects of the project. The establishment of such a station at Karachi had been mooted in the past, but owing to financial stringency the scheme seemed to have been indefinitely shelved. Nor was there any prospect of the proposal being brought to fruition now in view of the embarrassing financial situation in India. He favoured the location of the station in Bombay on account of its central position, and also because Bombay's comparatively vast population would be able to make a fairly large financial contribution towards the establishment of this station.

DR. SETNA of Bombay strongly supported the idea of establishing the Marine Biological Station at Bombay. He mentioned that such stations existed in practically all the important countries of the West, and he felt that there was a great need for a station like this in India. He further observed that the teaching of biology in India was somewhat defective, as pickled materials rather than living animals were mostly used for the teaching purposes. Hence our graduates lacked a knowledge of the biology of living animals. He pointed out that Dr. Kemp had suggested the Andaman islands as a suitable site for establishing a Marine Biological Station, but Dr. Setna thought that such a station should be located in close proximity to the principal marine routes and also near big fish markets. Since Krusadi and Andaman islands were far out of the way, they were not suitable for this purpose. Bombay, on the other hand, was more centrally situated. This city was a centre of commercial life not only of India but also of Asia. A small admission fee to the station would be a source of revenue from the floating population of Bombay. He also thought that utilitarian motives should not be the primary consideration in this connection. Bombay possessed good spots where this station could be located. The actual site could be selected later on. Modest beginnings could be made with a few tables, but the whole scheme would cost 80,000 to a lakh of rupees. Money was therefore the main problem and owing to the present financial stringency not much support from the Government can be expected. Moreover, the development of agriculture in the country was occupying the entire attention of the Government for the present. He said that he had approached private individuals and prominent citizens of Bombay, who had promised to give financial support to this scheme. He suggested that the authorities of the Science Congress should sanction a certain sum of money which would act as a nucleus of public subscription. He thought that various universities in India would also contribute handsomely towards this project.

DR. B. K. DAS. The views of the previous speaker were to a large extent echoed by Dr. Das from Hyderabad-Deccan, who favoured Bombay as a site for the projected station. Dr. Das felt that Bombay was easily accessible to a large number of universities in the mofussil. He said that it was of vital importance that students of zoology should familiarise themselves with the habits of living marine organisms in the knowledge of which they reveal striking deficiencies at present. Habits of living aquatic forms which are not so well known at present should be studied. He observed that departments of fisheries should be run on scientific lines. Whatever collections of marine animals and plants are made, these specimens should be sold under the auspices of the Marine Biological Station.

DR. S. K. MUKERJI supported Dr. Setna's plea for locating the station in Bombay. As an ecologist, he said that Bombay was conspicuous in possessing varied types of environments such as rocky and sandy shores and therefore the sea round about Bombay should be rich in ecologically divergent marine types. He felt that the time for passing fervent resolutions on paper had gone and they should now seize the present opportunity of setting up a Marine Biological Station in Bombay with modest beginnings. A combined committee of botanists and zoologists should be appointed by this joint session to work out a practicable scheme and suggest means and ways of giving effect to this scheme. For this purpose, funds were urgently required, and he thought that it would not be difficult to raise money, as the committee would seek the co-operation of various universities in India and the moral and financial support of the local and central Governments. He urged the delegates to support the choice of Bombay for the establishment of this station.

DR. S. L. GHOSE fervently supported Dr. Mukerji's idea of forming a committee and suggested that this committee should also be entrusted with the task of selecting a site.

PROF. R. H. DASTUR said that a small beginning should be made. The committee should formulate the various problems which the station would tackle, but suggested that these problems should be placed before the public who will then be willing to give funds.

PROF. AWATI in advancing Bombay's scheme said it possessed various types of environments such as rocky and sandy shores.

Prof. Gopala Aiyer in winding up the discussion said that he had no objection to any particular place; Bombay or Madras would be equally good to him.

Dr. S. L. Ghose of Lahore then moved that a committee of five biologists be appointed by this joint session of Botany and Zoology sections of the

Indian Science Congress to go into the question of establishing a Marine Biological Station in India. Dr. B. K. Das of Hyderabad-Deccan seconded this resolution, which was carried by a large majority of members present.

The following five persons were elected as members to this committee:—

(1) Dr. S. B. Setna of Bombay, *Convener*.
(2) Prof. Gopala Aiyer of Madras.
(3) Prof. George Mathai of Lahore.
(4) Prof. R. H. Dastur of Bombay.
(5) Dr. S. K. Mukerji of Lucknow.

After a hearty vote of thanks to the chair the meeting came to a close.

Continental Movement.*

By W. D. West, Esq., *Geological Survey of India, Calcutta.*

INFLUENCED by the teaching of Sir Charles Lyell, geologists for many years held the view that the oceans and continents of the present day were not permanent features, but that at times in the past the oceans had been dry land and the continents submerged beneath the sea. But when it was found that true deep sea deposits did not occur far inland, geologists began to doubt the truth of Lyell's teaching, and instead the doctrine of the permanence of continents and oceans became widely accepted. Now once more opinions are divided, and views on the structure of the surface of the earth have of late undergone rapid changes.

In considering the probable distribution of land and sea in the past, the present-day distribution of plants and animals is very suggestive. For long scientists have tried to explain the similarity of the land and freshwater faunas on the opposite sides of the Atlantic ocean. Thus the common garden snail is confined to western Europe, Iceland, Greenland and eastern North America. The perch, a freshwater fish, and the earthworm, a land animal, have a somewhat similar distribution, which suggests that the north Atlantic ocean has not been a permanent feature, for the sea would seem to be an insurmountable barrier to the migration of these animals. Turning to the south Atlantic, the freshwater fishes again provide striking evidence. The fishes of South America are very varied, but they bear no relationship whatever to those of North America. This is easily understandable when it is realised that the narrow strip of land joining North and South America is a comparatively recent feature, and that these two countries were until quite recently separate land masses. But the remarkable fact is that the freshwater fishes of South America and Africa, now so far apart, are remarkably alike, suggesting, according to Tate Regan, that the two continents were connected in Cretaceous times.

One more comparison may be drawn, which demands an explanation, and that is between the birds and mammals of the southern continents of South America, South Africa and Australia. The struthious birds, the rhea, ostrich and emu, closely allied and of a peculiar type, are found only in those three countries respectively; while the marsupials are confined to South America and Australia.

It might be claimed that the principle of convergent evolution explains the appearance of similar types of animals in far separated parts of the world. But the evidence of parasitology makes this extremely improbable. Thus Von Ihering and others have shown that the marsupials of Australia and South America are infested by the same parasites in the rectum; and the parasites of the ostrich and the rhea are identically the same, although these two animals are now confined to Africa and South America, between which there is only deep sea. It is surely expecting too much of convergent evolution to explain by its means the development of both host and parasite on exactly the same lines in different places.

To account for the distribution of these animals, and for many others which cannot be mentioned here, the orthodox method has been to introduce so-called 'land bridges' connecting the various continents, which would provide a ready means for the migration of land and freshwater faunas. This necessitates that these land bridges have since sunk beneath the sea, and here at once we are up against a difficulty. For the sinking of large continental tracts is inconsistent with the theory of isostasy, which postulates that the continents, composed of comparatively light granitic rocks of specific gravity about 2·6, are floating in an underlying layer of basalt of specific

* The substance of a popular lecture delivered before the Indian Science Congress at Patna.

gravity about 2·9. The latter is of course solid, but can be regarded as being similar to pitch, possessing rigidity but very little strength, and capable of flowing slightly over a long period of time. The principle of isostasy is really nothing other than that of ordinary floatation, and its acceptance makes it difficult to understand how portions of the continental crust can possibly have sunk, since the underlying basalt is heavier than the light continental rocks. Hence if these land connections ever existed it is not easy to understand how they can ever have sunk.

This, then, was the position until a few years before the Great War, when an alternative explanation was put forward by the American geologist F. B. Taylor, which was subsequently amplified by the Austrian meteorologist Alfred Wegener, after whose name the hypothesis is usually known. This explanation was first suggested by the remarkable parallelism between the east and west coasts of the Atlantic ocean, for it led Taylor, and later Wegener, to suggest that America on the one hand and Europe and Africa on the other had once been united and had since drifted apart. It was at once seen that this theory provided an easy way of explaining the biological anomalies, and was also free from the objection associated with the land bridge hypothesis, for it was not inconsistent with the theory of isostasy. Wegener went further than Taylor, and brought Australia and India against South Africa. In this way an explanation was offered of the almost simultaneous appearance of glacial conditions in South America, South Africa, India, and Australia in Upper Carboniferous times, which was followed at once by the appearance of the peculiar glossopteris flora in each country after the ice had disappeared. For Wegener supposed that these countries were still joined together in Carboniferous times, with the south pole in their midst, and that they subsequently slowly drifted apart to their present positions.

To return once more to the Atlantic. For the hypothesis of continental drift to be true, not only must the shapes of the two coastlines fit fairly well, but also the grain, or geological structure, of the lands on either side must correspond. As regards the north Atlantic, the two old mountain systems of Europe known as the Caledonian and Hercynian, formed at two different periods, gradually converge upon one another towards the west until on reaching Wales they meet. On crossing over to the other side of the Atlantic it is remarkable to find that the crossing of these systems, begun in western Europe, is continued in eastern North America at exactly the point where it is left off in Europe, as pointed out by Prof. E. B. Bailey, a fact unlikely to be observed had the Atlantic represented an area of sunken land. As regards the countries bordering the South Atlantic, the eminent South African geologist A. du Toit has shown that the geological fit is very fair, provided we leave a gap of about 500 miles between South America and South Africa.

Not only did Wegener claim that his hypothesis of continental drift explained the facts referred to above—biological, geological and climatological—but he also used it to explain the great Tertiary period of mountain formation which gave rise to the present great mountain systems of the world. For he supposed that it was the westward drift of the Americas which crumpled up the western margin of the continent to produce the Andes in South America and the great coastal ranges in North America; while the north-easterly movement of India away from Africa was responsible for the crumpling of the soft deposits of the sea which lay between what is now India and the rest of Asia, to give the Himalaya. A defect in this which should be mentioned is that Alps seem to have suffered as much crumpling as the Himalaya, and yet to move Africa as far north as Wegener moves India would completely spoil the Atlantic fit. The orthodox explanation of the formation of mountain ranges was to attribute them to the crumpling of the earth's crust consequent upon its cooling and contraction. But it can be shown that the amount of crumpling observed in the better known mountain ranges is far in excess of the total diminution in the circumference of the earth which can ever have been due to cooling. Moreover, the recognition of the part played by the disintegration of the radioactive elements, and the heat thus provided, makes it very doubtful if the earth has been uniformly cooling. And so Wegener's hypothesis explained yet another problem that had been worrying geologists. Is it a wonder then that this hypothesis, fantastic as it seemed at first, was received with open arms by

many scientists, and especially by those alpine geologists who had been impressed with the great foreshortening of the crust required for the formation of the Alps? But there has always remained one great obstacle to the full acceptance of the idea of continental drift, and that is there is no known force capable of producing this movement of the continents. Wegener postulated two forces, one acting towards the equator (producing the great meridional Alpine-Himalayan chain), and the other towards the west (producing the western American chains). But it can be shown that these forces, partly tidal in origin, are less than one-millionth part of the force required to tear the continents apart and move them over the face of the earth, though it is to be admitted that the time available is very great.

Summarily, the land bridge theory is open to the objection that it is inconsistent with the theory of isostasy; while for Wegener's theory of continental drift there is no known force adequate to do the work. Appeal to geological evidence, however, shows that both the sinking of continental tracts and the movement of continents have taken place in the past, at least to some extent, and facts of observation must be accounted more important than conclusions derived from theoretical arguments. Thus it is abundantly clear that there must have been sinking of the crust to the extent of many thousands of feet in those geosynclinal seas which became the sites of mountain ranges, in order to account for the continuous deposition of so great a thickness of comparatively shallow water deposits. It is difficult to understand the mechanism of such movement, but our President, Dr. Fermor, has put forward the enlightening suggestion that the underlying basalt may at times change to a rock of similar composition but greater density, such as eclogite, the local contraction involved in this change accounting for local subsidence. That this may be so is suggested by the curious earthquake phenomena which have from time to time characterized the earthquakes of Assam. There can be little doubt that actual sinking of the crust is taking place along the Brahmaputra valley, which is probably a rift valley separating the Assam plateau from the rest of India; and the fact that many of the earthquakes which take place in this area are not related to any particular epicentre, but seem to take place simultaneously over a large area, suggests that some sudden change is taking place in the rocks beneath the crust, a change which might well be of the nature of basalt to eclogite. The theory of isostasy has probably been considerably overworked in the past. It should not be regarded as the prime force in mountain formation, but only as a modifying influence which plays its part after the main action is over. Clearly what must happen, both during the geosynclinal period when subsidence is going on and during the subsequent phase of compression, is that the isostatic balance is temporarily thrown out of adjustment, and only towards the end does it restore the balance disturbed by the greater forces which have been in operation. Then as regards the difficulty of pointing to any force capable of moving the continents, an obvious answer to this objection is that a force which can compress the rocks to form great mountain ranges like the Himalaya should be competent to shift the continents as a whole. The very fact of folding implies horizontal movement. To take the case of the Himalaya, there can be no doubt whatever that Asia and India must have approached one another during Tertiary times to the extent of at least several hundred miles, to account for the observed folding; and if that amount of continental movement has to be admitted, then why not the greater drift required by Wegener?

As in all complicated problems, the difference of opinion which they give rise to generally leads to a solution which is a '*via media*. As regards the question of the permanence of the oceans, the Atlantic is probably to be regarded as an ocean of comparatively recent origin, at any rate in its present form, and the same may apply to the Arabian sea; for there can be little doubt that the great plateau of Deccan trap must once have extended many miles westward of its present limit, now fixed by the coastline of Bombay. But the Pacific has the impress of greater antiquity, a conclusion supported by recent seismological researches. That there must have been continental movement of some kind on more than one occasion in the past has, I think, to be admitted. But whether it was just in the way pictured by Wegener is more open to doubt. The accurate determinations of longitude by wireless which are now being made should provide in ten or fifteen years

time definite evidence as to whether movement of the continents is now taking place. For one thing Wegener must be given the credit. He has provided a great stimulus to geological thought during recent years, and many of our present ideas on earth tectonics are directly attributable to him. The problem, although essentially a geological one, is also one which can only be adequately solved with the help of all the sciences, and it is for that reason that I chose it as the subject of an evening lecture before the Indian Science Congress.

Research Notes.

Investigations on Magne-crystallic Action. Part I.—Diamagnetics.

[K. S. Krishnan, B. C. Guha and S. Banerjee. *Phil. Trans. Roy. Soc.*, **A. 231**, 235, 1933.]

IN this paper the authors report an extensive investigation on the magnetic anisotropy exhibited by single crystals. The object of the research is to obtain information on the orientation of the molecules in the unit cell by means of magnetic measurements. This is made possible by the fact that the differences of susceptibility in different directions depend upon the orientation of the molecules and not on their position. The difference in susceptibility is directly measured by suspending the crystal in the uniform field of a large electromagnet with plane pole pieces. The crystal is attached to a moderately thin glass fibre of 7 to 8 mm. length, and the fine suspension fibre of quartz is attached at one end to the glass fibre and at the other end to a torsion head. The latter is so rotated that there is no torsion in the fibre when the direction of maximum susceptibility in the plane of oscillation is parallel to the field. The periods of oscillation, T and T^1, with and without the field being determined, the difference of susceptibility is calculated by the formula

$$X_1 - X = \frac{T^{12} - T^2}{T^2} \cdot \frac{C}{H^2} \cdot \frac{M}{m},$$

where X_1 and X_2 are the maximum and minimum values of the gram molecular susceptibility of the crystal in the plane of oscillation, C is the torsion constant of the fibre, *m* the mass of the crystal and M its molecular weight.

The results of measurements made on a large number of crystals are given in the paper. The striking fact revealed by these data is the large magnetic anisotropy of the nitrates, carbonates and the chlorate, while the sulphates are more or less completely isotropic. The behaviour of the nitrates and carbonates is explained by the intrinsic anisotropy of the NO_3^- and $CO_3^{=}$ ions and the parallel orientations of all the ions in the crystal. The contribution of the metallic ions to the susceptibility seems to be isotropic. The anisotropy of the NO_3^- and $CO_3^{=}$ ions is stated to be probably connected with their plane structure; the fact that strong magnetic anisotropy is usually associated with optical anisotropy is thus explained. The isotropy of the $SO_4^{=}$ ion is also shown to be in agreement with the results of X-ray investigations. From the behaviour of the ClO_3^- ion it is concluded that the structure of this ion is probably pyramidal with Cl at the apex.

Measurements have also been made on a number of organic crystals, while their absolute susceptibilities have been determined so as to fill the gap in the existing data. A null method of the type used by Rabi (*Phys. Rev.*, **29**, 174, 1927) has been employed for the purpose The susceptibilities of the fused crystals have also been determined by the modified Quincke method used by Ranganadham. It has been found that there is no change in susceptibility on fusion in the case of naphthalene, while benzophenone showed a change of about 2·5%. Further experiments are promised with a view to discover if this difference in behaviour is connected with the dipole moments of the substances. Detailed discussions of the molecular orientation are given in the case of naphthalene, anthracene, biphenyl, dibenzyl, azobenzene, stilbene, β-naphthol and acenaphthene. It is concluded that magnetic measurements can yield the entire molecular orientations in the unit cell in favourable cases like biphenyl and dibenzyl, while in less favourable cases, some of the angular parameters that determine the orientations can be derived as in naphthalene and anthracene. Finally, the authors conclude that any structure proposed on X-ray or other considerations can be acceptable only when it is in agreement with the results of magnetic measurements.

Preliminary Observations on some Polychæte Larvæ of the Madras Coast and a Note on the Occurrence in Townet Water of the Larvæ of Chætogordius ? Moore.

PROF. R. GOPALA IYER deals with a collection of Polychæte larvæ (*Journ. Madras Univ.*, Vol. V, No. 1) obtained in townet water from the Madras coast. A general idea of the seasonal occurrence of the various larvæ is given and observations on the larval development of some of the common genera are also made. It is pointed out that *Mitraria* larvæ stand out first in point of numbers and they attain maximum number in August. *Spionids* come next and are characteristic of the plankton during the months of November and December and to a lesser extent in January. *Terrebellids*, represented by the post larval stages of *Loimia medusa*, have been observed to turn up with singular regularity about the middle of June and November. *Nephthyds* and *Phyllodocids* occur in fairly large numbers during the months of December and January while *Eunicids* and *Polynoids* have March and April as their favourite months. *Nereids*, never very numerous, could be picked up during February and March. *Chætosphærids* and *Chætopterids* occur in small numbers in November and March while *Mageloņoids*, represented by the post larval stages of *Magelona papillicornis*, occur in November and January.

Observations on some of the developmental stages of *Phyllogoce*, *Nephthys*, *Eunice*, *Glycera*, *Eone*, *Chætosphæra*, *Chætopterus*, *Telepsavus*, *Magelona*, *Loimia*, *Capitella* and *Sabellaria* are given. Unfortunately in most of the above mentioned cases specific identification of the larvæ was not found possible. A fairly connected account of the larval development of what is probably a species of *Chætogordius* is also given.

Microscopical Study of some Indian Coals.

MICROSCOPIC examination of coal has been for some years an established branch of study in Europe and America and is being recognized as an useful adjunct to the study of coal seams. Mr. A. K. Banerji has published in the last issue of the *Records of the Geological Survey of India* (Vol. LXVI, p. 333) some highly interesting results derived by the microscopic study of some samples of Indian Gondwana and Tertiary coals, in which he employed the modern technique of coal petrography. Examination of two samples of gondwana coal has shown that woody stems contributed to some extent to the formation of the coals; they may, therefore, be said to have originated from tree-like plants. The presence of Araucarian pitting has been definitely established, while no scalariform tracheids characteristic of the *Filicales* has been observed. This seems to indicate a gymnospermous affinity of a portion at least of the flora, especially as megaspores are completely absent. One of the most striking features of the Indian tertiary coals is the relatively frequent occurrence of sclerotium bodies of certain fungi, partly differentiated into several cells and partly simple. It will be important to observe whether these bodies occur with the same frequency in the brown coals or lignites from other parts of the world.

The Relative Numbers of Immature Erythrocytes in the Circulating Blood of Several Species of Marine Fishes.

DAWSON, B. ALDEN, has made a comprehensive study of the blood of general circulation of twenty species of marine fishes (*Biol. Bull.*, **64**, 1, 1933), and has noticed that the number of immature erythrocytes varies widely. The differential erythrocyte counts were based largely on supravital preparations stained with brilliant creysl blue. The twenty species were divided into four groups and each group presented a varying count of immature erythrocytes. The variations were according to their mode of adaptations such as their type of external respiratory mechanism, the efficiency of their oxygen transporting system, their oxygen requirements and the oxygen tensions of their environments.

The Vellalas of Travancore.

THE article on Vellalas of Travancore by Mr. L. A. Krishna Iyer (*Journal of the Madras University*, Vol. V, No. 1, Jan. 1933) is an interesting contribution to South Indian Ethnology. They are an isolated group of early Dravidians retaining and practising some of the primitive social customs, eking out a scanty livelihood from agricultural pursuits. They are a poor community diminishing in numbers; the inhospitable areas which they inhabit smite

them with disease and cripple their energy. In personal appearance they have a dark complexion with an inclination to dolichocephaty head and a broad nose. Having lived in contact with the civilised Hindus, they have adopted their Gods for worship, their rules of inheritance, the panchayat system for settlement of disputes, funeral ceremonies and instincts of personal gold and silver ornaments. These are recent acquisitions. The physical anthropology of the primitive tribes of India is a field of study which is likely to yield fruitful results and before these interesting groups disappear, a comprehensive investigation should be undertaken. Ethnological investigations have revealed that social customs and habits, the superstitious faiths and religious practices, the code of morality and sex relations have had a parallel evolution among the primitive tribes and a comparative study of physical anthropology of the Indian primitive communities may throw light upon their origin, places of settlement, their lines of migration and the factors of differentiation.

On the Singularities of Laplace-Abel Integral.

IN the course of a lengthy memoir published in the *Math. Zeitschrift.* Band 29 (1929), Polya has discussed the properties of the integral $\int_0^\infty F(Z)e^{-zZ}dZ$ where F(Z) is an integral function of what he calls "the exponential type" *i.e.* $|F(Z)| < Ae^{a|Z|}$. The paper published by P. L. Srivastava and S. P. Jain in the *Bulletin of the Academy of Sciences*, U.P., Vol. II, No. 2, Decr. 1932, considers instead of an integral function, an analytic function $\phi(Z)$ again of the exponential type, analytic in the region $|\text{amp } Z| < a\ (>0)$, and discusses what analogous results can be established for the integral $\int \phi(Z)\, e^{-zZ}dZ$. The introduction of a function $\underset{P\to\infty}{\text{tim}} \dfrac{\log|\phi(Pe^{i\phi})|}{P}$ exactly analogous to what Polya calls the *indicator* leads to the required results.

Among some of the striking results are the following:

(1) If $f_1(s) = \int_0^\infty \phi(a+Z)e^{-sZ}dZ$, and

$$f_2(s) = \int_0^\infty \phi(b+Z)e^{-sZ}dZ,$$

where a and b are points inside the region wherein $\phi(Z)$ is analytic, then $f_1(s)$ and $f_2(s)$ have the same line of absolute convergence and the same singularities.

(2) A similar result for the series $f_1(s) = \sum_0^\infty \phi(a+n)e^{-sn}$ and $f_2(s) = \sum_0^\infty \phi(b+n)e^{-sn}$.

As a corollary, the singularities of the Dirichlet series $\sum_1^\infty \phi(\log n)\, n^{-s+1}$ and of the integral $\int_0^\infty \phi(Z)e^{-sZ}dZ$ are identical.

The authors' abstract of their paper has been published in the *Comptes Rendus*, Tome. 194, pp. 2111–2113. The authors call the integral $\int_0^\infty \phi(Z)e^{-sZ}dZ$ the Laplace–Abel integral. Is there a slip, Abel replacing Borel? The analogy of the integral to Dirichlet's series would justify the association of the name of Dirichlet as well.

Mitosis in Hydra. Mitosis in the Ecto-dermal-Epithelio Muscular Cells of Hydra.

CARL H. MCCONNELL describes the mitotic phenomenon in the ecto-epithelio-muscular cells of Hydra and the appearance of this kind of activity is exceptional (*Biol. Bull.*, **64**, 86, 1933). Interstitial cells divide mitotically and endoderm cells propagate themselves by amitotic divisions. The author has demonstrated nevertheless mitotic divisions in the ecto-epithelio-muscular cells. He has observed different stages of mitosis from prophase to telophase in about 205 preparations he has studied and thus establishes beyond doubt that mitosis is the rule rather than an exception. Mitotis figures are found in all parts of the body except the epithelio-muscular cells of the tentacles and are generally restricted to, or at least more numerous in, the upper two-thirds of the body. The centrioles and asters are present and the chromosome number is 12. It is further observed that mitotic phenomenon in Hydra occurs under all conditions.

According to previous observers the absence of mitotic division in the epithelio-muscular cells rendered their replacement by cells elaborated from the indifferent cells. The suggestion that an activity in the ecto- and endo-indifferent cells leading ultimately to cells which replace ecto- and endo-epithelio-muscular cells is denied on the basis of accurate observation. It is therefore suggested that the endo- and ecto-epithelio-muscular cells are self-propagating by a process of mitosis while the ecto- and endo-epithelial cells are concerned in the formation of sperm, egg and nematocysts among other functions.

The Nattukottai Chettiars.

DR. P. J. THOMAS has written an illuminating article on this community of indigenous bankers in the *Journal of the Madras University*, Vol. V, No. 1, January 1933. The Chettiars form a strong ethnic race of the Dravidian stock, distinguished for their extreme frugality and simplicity of habits, their strong individualism and spirit of enterprise, no less than their charitable disposition, religious endowments and munificent bequests to learning. The Indian Banking Communities, in addition to being money-lenders, are also merchants, commercial agents, landowners and managers of mills and factories; but the Chettiars as a rule avoid trade and other business concerns and if in recent years they have come to deal in gold or to occupy lands and plantations, they have been forced on them as unredeemed pledges. Though extremely thrifty in their personal comforts, they possess the primitive instincts of extravagant display of wealth as is evidenced by the total investment in houses and jewels amounting to about fourteen crores of rupees. It is estimated that the total capital employed by the Nattukottai community in their banking concerns is about rupees 120 crores, spread over Burma, Malay Peninsula, Straits Settlements, Ceylon, Cochin, China and Madras Presidency. The greater part of this working capital is derived from the proprietors and a small fraction of it is composed of deposits and advances and overdrafts from Joint-Stock Banks. The success of this community is due to their avoidance of all speculations and their interlocking of business interests which guarantees each other generous assistance in times of need. The custom of setting up a young married man in business either as a partner in old established concerns or independently has tended to promote independence and self-reliance among the members and the training in conservative business methods which a young apprentice receives fosters the traditional spirit of caution and shrewdness. Within recent years, the prominent members of this community like Sir Annamalai Chettiyar, Rajkumar Muthia Chettiyar have entered public life and have made notable contributions, and to the munificence of the former, one of the flourishing South Indian Universities owes its origin. Like the Jews of old, money-lenders have always suffered and in Indo-China where the Chettiyars have extensive banking interests, the decree-holders are threatened with expulsion from the French territory if they dared to execute the decrees against the offending debtors and an order of this nature on the part of the French Government in Saigon is likely to affect seriously the flow of trade and the availability of liquid money for the promotion of commerce. Dr. Thomas has made an important suggestion in regard to the future business of this important community. He has pointed out that private money-lending may not prove a profitable concern when the country is being rapidly industrialised and industrial investment is likely to prove of great benefit to their own interests and those of the country. This is especially so when it is remembered that an efficient system of large-scale industry is of prime importance for the prosperity of India and none can finance it with greater success than the shrewd and businesslike Nagarthars.

The Mechanism of Adaptation to varying Salinity in the Common Eel and the General Problem of Osmotic Regulation in Fishes.

(*P.R.S.*, Ser. B., **112**, 576, 1933.)

IT is of common knowledge that teleost fishes could live in fresh water and salt water as well. Ancel Keys in a very interesting article describes the various experiments conducted and the results. It is pointed out that the eel behaves as a fresh-water fish in a medium of fresh water and as a marine fish in sea water. Further the blood of the euryhaline species in sea water is practically indistinguishable in osmotic concentration from the blood of the stenohaline marine forms. Both types are capable of extracting water from

sea water and in the euryhaline fishes and fresh water teleosts the kidney assists in filtration. This point has been experimentally determined.

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The Growth of the Nucleus in the Developing Egg of *Chlorohydra viridissimi.*

CONCERNING the development of the egg of Hydra, there have been various theories advanced by different schools of thought. It has been maintained by some authors that the eggs are differentiated from a few of the not too specialised interstitial cells, a majority of the latter being used as food for the developing egg. Only one egg ultimately reaches maturity. Carl H. McConnell makes the suggestion (*Biol. Bull.*, **64**, 103, 1933) that several functional eggs develop in the ovary simultaneously. The interstitial cells destined to develop into eggs are easily distinguishable from others by the size of the cell, the peculiar nucleus and the cytoplasmic contents. The fate of the nucleus of the developing egg has been studied and it apparently maintains a ratio of 1 : 9·66 to the cytoplasm. The cytoplasm ceases increasing in volume after the nucleus reaches a certain size. The nucleoli increase in number in relation to the size of the nucleus. The maturation process is heralded by the vacuolisation of the nuclear membrane and during the process of maturation the volume of the nucleus is an eighth of its volume prior to maturation.

Some Relict Races of *Cottus quadricornis* from Finland.

FROM a geological point of view Finland is very interesting and its numerous lakes, till very recently, formed part of the sea. Relict races of different forms of animals have been described from these lakes and not the least important are those of *Cottus quadricornis* examined by E. Lonneberg (*Ark. for Zool.*, Band 24, Haft 3, 1933). He finds certain differences between typical marine forms of *C. quadricornis* and the relict races from the different lakes of Finland, associating the absence of spinous scales and other secondary sexual characters to the lack of calcium salts in the waters of the lakes in which these fishes are obliged to live.

On the Respiratory Function of the Blood of the Porpoise.

GREEN, Arda A., and Alfred C. Redfield have set forth (*Biol. Bull.*, **64**, 44, 1933) experimental data obtained as a result of an examination of the physico-chemical properties of the respiratory fluids of these aquatic mammals. The properties of blood are very similar to those of the terrestrial mammals. The only clear-cut aquatic adaptation recognizable in the corpuscles of the cetacean and the sea-lion is the increased concentration of haemoglobin in the corpuscles. Aquatic life though it brings about morphological adaptive modifications does not significantly affect the physico-chemical properties of blood.

Science News.

The Chromosome Number of Cleome viscosa Linn.—DR. E. K. JANAKI AMMAL, D.SC., F.L.S., Department of Botany, College of Science, Trivandrum, writes:—

"Pollen mother cells of Cleome viscosa Linn. were crushed into a drop of acetocarmine solution as described by Belling (1926). The cytoplasm of the P.M.C.'s when viewed immediately after this treatment, showed large numbers of oil globules. These screened the nucleus so that the Chromosomes were not visible. When slides were set aside for about a couple of hours the globules disappeared and the chromosomes could be clearly seen. The metaphase plate showed the haploid number in Cleome viscosa to be 10.

Reduction division in P.M.C.'s occurred at about 9 A.M. in January and February."

* * *

M. CHARLES MARIE, Secretaire General, Societe de Chimie Physique, Paris, writes:—

"The Society of Physical Chemistry is going to celebrate its 25th Anniversary this year. Arrangements are made for festivities to take place in the 3rd week of October, such as usual: an assembly, receptions, a banquet, etc. The Society found it also desirable to profit of this occasion and to arrange a general discussion on one of the modern scientific points. The subject of the discussion is to be: 'Electron Theory of Metals—Electrolytes and the intermediate layers Electrode-Solution.'

A number of scientists, foreign and French, have been asked to contribute Reports. All those Reports are going to be printed and the proof-sheets distributed to the Members of the meeting. In order to make this meeting an international one, the Reports are to be published in the author's native language: German, English, Italian or French.

The Society of Physical Chemistry should be extremely pleased to meet some of the Indian colleagues as members of the Congress. Applications have to be sent as soon as possible, eventually before June 30th, the beginning of the summer holidays, and not later than September 30th. The sum of 125 francs has to be adjoined, to cover the expenses of the receptions, banquet, etc., as well as the costs of the preliminary Reports. mentioned above.

The applications have to be forwarded at the address of the General Secretary, Dr. Ch. Marie, 9, rue de Bagneux, Paris (VI°)."

* * *

Mosquito and Charophyta.—DR. S. L. GHOSE, President of the Botany Section, 20th Indian Science Congress, writes:—

"The sentences quoted in Mr. Dixit's note are from a review on the Presidential Address of the Botany Section of the last Science Congress, and not from the address itself which evidently has not been read by Mr. Dixit. The following is an extract from the address and will speak for itself: 'In 1923 Vasconcelos drew attention to certain species of *Chara* which seemed to cause the death of mosquito larvæ by a poison which the latter obtained by feeding on them (100). In 1928, Messrs. Mathesan and Hinman published a paper on their observations on *Chara fragilis* in connection with mosquito and asserted that the plant growing in still and running water aquaria of various kinds prevented mosquito breeding (74). When the plant was decaying normal development of the larvæ took place, but when the plant recovered the larval growth was inhibited. Experiments on this alleged larvicidal property of the species of *Chara* have been recently made by Mr. Paul of Burma, Mr. Blow of England and Dr. Hamlyn-Harris of Australia (81, 9). These three workers seem to have got negative results. It is very desirable, therefore, that experiments should be made in our country, and the question of the larvicidal property of *Chara* species be finally settled, at least as far as India is concerned.'

One is glad to learn that Mr. Dixit has also given some attention to this problem and is able to confirm Mr. Pal's results. It will be very interesting, however, if he would publish a list of the species of *Chara* he has observed in this connection, especially of those from Santa Cruz which is said to be full of mosquitoes in spite of its vast areas being covered by Charophyta. The presence or absence of particular species of *Chara* may make all the difference. The following extracts from Mr. Pal's paper should be read along with the sentence quoted from it in Mr. Dixit's note: 'At the same time it appears to be a well-established fact that mosquito larvæ are absent from ponds containing Charophytes......In my experience, likewise, similar conditions exist in Burma, and ponds containing mosquito larvæ do not contain Charophytes and *vice versa*......It is just possible, of course, that the properties of different species, as far as destruction of mosquito larvæ is concerned, is different, and this may be an explanation of the contradictory results obtained by various workers. Unfortunately, *C. fragilis*, the species used by Mathesan and Hinman, was not available in Rangoon for experimental purposes. If it is really useful in the destruction of mosquito larvæ it would be worth while to introduce it to various regions.'

It is clear, therefore, that the problem is not definitely solved yet. The last sentence of Mr. Dixit's note, however, would assume that it is so and would tend to kill further research into the subject, and that is rather deplorable."

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(9) Blow, T. B., 'On the alleged larvicidal property of *Chara fragilis*'. *Proc. Linn. Soc. Lond.*, 1930-31, pp. 129-132.

(74) Mathesan, R., and Hinman, E. H., '*Chara fragilis*, and mosquito development.' *Amer. Journ. Hyg.*, VIII, 1928, pp. 279-292.

(81) Pal, B. P., 'Burmese Charophyta.' *Journ. Linn. Soc. Lond.*, XLIX, 1932, pp. 47-92.

(100) Vasconcelos, A. B., 'The algæ of the genus *Chara* and mosquito larva.' *Amer. Jour. Pub. Health*, XIII, 1923, p. 543.

* * *

Inhabitants of Waterfalls.—In his talk to the Rotary Club, Calcutta, on 27th. Sept. 1932, Dr. S. L. Hora enumerated the several interesting forms of animal life that have adapted themselves to this perilous habitat. A waterfall is a very unique blend of unusual factors and at first sight an impossible situation for animal life, it is truly surprising how many forms have made this their

home, adapting themselves in a remarkable manner to this dangerous situation. Of the fishes that live in or near waterfalls, the salmon is notable for its feats of leaping great heights to overcome obstacles in its ascent of a river. In India, the famous mahseer is said to be capable of similar feats.

For holding on to the substratum and thus withstand the rapidity of the stream, a variety of organs is developed in animals. In *Garra* the suctorial disc behind the mouth and the numerous adhesive pads developed by the skin in certain situations serve the purpose and this fish is capable of climbing up steep sides of a rock against a current to a height of nearly thirty feet. The tadpoles of *Rana afghana* bear similar adhesive suckers behind the mouth enabling it to withstand the fiercest currents. *Arges*, the South Amercan Hill stream fish, uses its lips and ventral fins alternately for ascending vertical walls of rocks. In *Pseudecheneis* there is a broad corrugated adhesive disc on the ventral surface. The paired fins are used in *Balitora* and *Gastromyzon* for progression. The tadpoles of *Bufo penangensis* has its lips modified to form a powerful sucker. The same is the case in the tadpoles of *Helophryne* and *Ascaphus truei*.

Perhaps the most dangerous situation in a waterfall for animals to live in is its lip and here probably we meet with the profoundest modifications of animal body to enable it to cling to rocks. The *Blepharocerid* larvæ bear on the ventral surface a number of suckers capable of independent attachment and even help in locomotion. Associated with the *Blepharoceridæ* are the larvæ of *Deuterophlebia* which have developed seven pairs of abdominal outgrowths which enable the animals to grapple bare rocks. The nymphs of *Iron* has a most complex type of adaptive modifications. Its broad ventral surface applies itself to the substratum and its gill lamellæ provided with spinous pads enable the animal to cling to bare rocks very tenaciously.

Even the base of the fall which is one of the last situations where one expects animal life, has its fauna and while some live on the top of the rocks below exposed to the cataract, others rest at their sides. Of the former, the chiton-like larvæ of *Blepharocerids* are important, which by their flat bodies cling to the rocks and do not allow any water to flow underneath them. The pupæ of Caddis flies commonly occur on the sides of the rocks at the base of the fall.

* * *

Respiration in Fishes.—Dr. S. L. Hora's lecture at the Indian Museum on the 8th. December 1932 brings our knowledge of the respiration of fishes up to date. He has dealt with this intensely technical subject in a popular and attractive manner. There is a large number of fishes in India which have adapted their respiratory organs in diverse ways to their peculiar habitats and Dr. Hora has endeavoured to clear certain misconceptions about them, his personal observations on many of them being of great value. He describes at length the physiology of typical gill respiration and proceeds to consider the variations from this type. In the parasitic lampreys and hag-fishes, the gills are pouchlike and the gill openings serve both as exhalent and inhalent apertures. The spiracle, in the Skate, is used as the inhalent aperture, the water passing out through the gill apertures. In the Plaice also, the gill apertures serve both as incurrent and excurrent apertures. The way the respiratory organs are modified in hill stream fishes is truly remarkable. There really seems to be a correlation between the rate of movement (and the general activity) of the animals and that of the medium in which they live. In cases where the latter is markedly great, the former is inconsiderable and *vice versa*. It is well known that the flow of water in hill streams is very rapid and all the fishes have to do is to stick to a place. Accordingly and on account of the high oxygenation of the waters, the respiratory organs of hill stream fishes have become profoundly modified. Special grooves are developed in many of them along the corners of the mouth taking water to the gills and probably the extreme case is that offered by Sewellia where the rostral groove bears a special aperture through which the current of water probably enters the gill chambers.

In the remarkable Gyrinocheilus and Arges, the mouth is not used to take in water but the gill opening itself is divided into two parts,—an upper inhalent and a lower exhalent aperture. In both cases, the mouth is applied to the substratum and in no way aids in respiration. Amblyceps is another hill stream fish which has adapted itself to the varying water constitution of its streams. While during the rainy months, it is capable of respiring normally, diminished in oxygen, the animal can take in quantities of air into its gill chambers and thereby respire.

The case of Amblysceps leads us to more interesting forms where, instead of but a seasonal development, this air breathing habit has become a constant, permanent and accessory mode of respiration. The cases of Anabas, Clarias, Saccobranchus, Amphipnous and Ophiocephalus are too well known to us. In all these cases a variety of structures is developed to enable the animals to breathe air and what is probably more interesting is that in all these cases breathing air has become an indispensable necessity without occasional recourse to which the animals seem unable to live.

To Dr. Hora's list of Indian air breathing fishes can be added with advantage a small brackish water fish, Rhyncobdella, occurring in Calcutta. The normal mode of respiration of this fish is by means of gills. The gill-cover, however, bears along its posterior border, tiny serrations, which, on application to the body wall, close the gill aperture effectively. The fish is occasionally seen to come to the surface, take a bubble of air through its mouth and transfer it to the gill chamber whose walls are highly vascular and which is now closed in the manner described. Retaining this little bubble of air in its gill chamber, which now bulges out just as in Amblyceps the fish moves about beneath the surface. After a few minutes the gill cover is lifted, the bubble escapes and the fish resumes its usual method of gill respiration. Even here, air breathing has become indispensable, for as Day observes, the fish conceals itself in mud and becomes drowned in water if unable to reach the surface, as it apparently requires to respire air directly.

What bearing the development of an air breathing habit has on the origin and evolution of terrestrial vertebrates cannot be stated with

definiteness but that the air breathing habit was developed as an adaptation to the varying modes of life of fishes is certain.

* * *

MR. N. R. RAGHUNATHACHARI of the Maharajah's College, Vizianagaram, writes:—"With reference to scorpions, the Cambridge Natural History says that they live upon centipedes, insects and spiders, which they kill by their sting before eating. The incident which is now recorded corroborates the fact. Mr. V. Subba Rao, Electrician of the Vizianagaram Fort Power House, saw a scorpion (a species of Buthus) in the act of eating a centipede (a species of Scolopendra) at 8-30 A.M. on the 19th. instant. The arachnid was clinging half-way up a wooden door of the Power House. For nearly 30 minutes the scorpion did not move from the spot and was busy with its work. It was photographed in action. The head of the centipede's body was eaten away, leaving no remnants. The scorpion held the prey by the pedipalps, often taking it away from the mouth and then bringing it near."

* * *

With reference to the article "The Problem of the Lantana" by Mr. A. V. Varadaraja Iyengar (*Cur. Science*, **1**, 266, 1933), Messrs. M. SAYEEDUDDIN and M. ABDUS SALAM of the Botany Department, Osmania University College, Hyderabad, write:—"Lantana camara is found all over the Dominions, especially along roadsides and waste places. It is very interesting to note that in the majority of cases where there is cactus there is lantana present. Careful examination of lantana and cactus where they grow side by side reveals that the roots of the former remain quite separate from those of the latter. There is neither symbiosis nor parasitism. The only explanation we can offer at this stage is, that the habitat of both the plants is the same, and that they are xerophytes of common habits, and hence prefer similar environment. There is very little difficulty or hardly any in regarding lantana xerophyte owing to the facts that its leaves are more or less leathery, covered with fine hairs. The stem too is covered with hairs and studded with prickles. One more point in its favour is that the foliage is rather scanty which also helps in placing it amongst the xerophytes. It is for this reason that it is so hardy. We are not quite sure if the soil analysis will help us in clearing this up. Possibly by such an examination some relationship as to its surroundings may be established. Some more observations are being made on the characters and the association of these two plants.

About the uses of lantana, we have just to say a few words. As far as we are aware of, we are still in the dark as to its medicinal properties. We know that lantana contains an alkaloid named "Lantanine", which is similar to quinine in its properties in so far as it depresses the circulation and lowers the temperature. Kirtikar mentions that intermittent fevers which have not yielded to treatment with quinine have given way under the use of 2 grams of "lantanine". We have used with a marked degree of success the oil from the leaves of Lantana to cure itchness of the skin. We believe that the oil could be used as a sort of antiseptic for wounds, etc. It is for the Biochemists to investigate further into the properties of the oil, and the uses to which it can be put with success."

* * *

Origin of Leafy Sporophytes in Ferns.—Mr. G. P. Majumdar, Department of Botany, Presidency College, Calcutta, in the course of a communication writes confirming Coulter's homologous theory of alternation of generations among the sporophytes in ferns. He has given other citations in support of this observation.

* * *

Occurrence of Chert.—Reddipalayam, Tanjore. MR. T. N. MUTHUSWAMI of the Department of Geology, College of Engineering, Guindy, Madras, writes:—

"A band of Chert about 100 feet long has been observed at Reddipalayam, Tanjore, containing fossils of Lamellibranchs and Gastropods with some forams. Further studies are in progress as to its age in relation to the Cuddalore Sandstones."

* * *

We acknowledge with thanks the receipt of the following:—

"Journal of the Indian Chemical Society"—Vol. 9, No. 12, Dec. 1932.

"Indian Forester"—Vol. 59, No. 3, March 1933.

"Nature"—Vol. 131, Nos. 3302-3305.

"Chemical Age"—Vol. 28, Nos. 711-714.

"Scientific Indian"—Vol. 9, No. 50, Feb. 1933.

"Proceedings of the Annual Meeting of the Asiatic Society of Bengal."

"Archiv Fur Zoologie"—Band 24, Hafte 3-4.

"Canadian Journal of Research"—Vol. 8, No. 1, Jan. 1933.

"Berichte der Deutschen Chemischen Gessellschaft"—66 Jahrg No. 3, March 1933.

"Journal of the Indian Mathematical Society"—Vol. 19, No. 12.

"Transaction of the Mining and Geological Institute of India"—Vol. 27, Part 4.

"The Quarterly Journal of the Geological Mining and Metallurgical Society of India"—Vol. 4, No. 3.

"Journal of General Chemistry"—(Russian Chemical Society) Vol. 2, No. 54, Parts 9 & 10.

Reviews.

THROUGH WONDERLANDS OF THE UNIVERSE. By R. K. Golikere. Demy 8vo. Pp. xviii + 400 with Frontispiece. D. B. Taraporevala Sons & Co., Hornby Road, Bombay. Kegan Paul & Co., London. Price Rs. 6-4-0.

The book deals with a variety of topics of geographical, geological, physical, astronomical and astrophysical nature. It begins with a short history of the earth, its geological formation and then gives a collection of strange finds in its interior. The next chapter is a collection of interesting facts about the hydrosphere, with a brief account of marine zoology at the end. Then follow chapters dealing with the land surface, volcanoes and the atmosphere, all written in the same strain. The chapter on the volcanoes gives a detailed account of the great eruption of Krakatoa in 1883. These accounts form about two-thirds of the book. The concluding chapters deal in a rather hurried fashion with the solar system, the galactic system, the physical condition of stars and the nebulæ. There is a small chapter on the projection of rockets to the moon and other worlds which forms thrilling columns in the newspapers, and we believe that this topic is sure to appeal to the popular mind. The subject of the finitude of space and of the expanding universe also find a place in the book, although this part seems to be too much overburdened with the opinions of Sir Arthur Eddington and Sir James Jeans.

The last two chapters give a brief account of the history of Astronomy in Asia and an account of the atomic theory and theory of evolution as conceived by the ancient Hindus. One would have liked to know how the Purāṇas reached the figure of 1,960,853,034 years regarding the age of the earth. Our author thinks that this figure compares favourably with those computed from recent scientific data, but one who is familiar with the various assumptions made in these computations should proceed rather cautiously with them.

On account of the large variety of topics dealt with, the book looks more like a compilation of facts than a systematic and unified presentation of the principles. The author must be however congratulated for having collected accurate and up-to-date information about such diverse subjects. It is refreshing to find that the author has not failed to notice the sensational happenings of the year of publication of the book, *viz.*, 1932. Such is for example the hypothesis of Neutrons. Again, the cosmic ray expedition to the Himalayas organized by Prof. Compton and led by Prof. Benade of Lahore which concluded in September last has not escaped the author's notice. One however misses illustrations, which more than anything else appeal to popular imagination. On the whole the author has been successful in his object of producing a book intended to awaken a taste for Science amongst laymen who ordinarily do not take any interest in it.

M. N. SAHA.

* * *

CHEMICAL WAVE TRANSMISSION IN NERVE. By A. V. Hill, F.R.S. Pp. ix+74; 13 Figures. The Cambridge University Press, 1932. Price 5*sh.* net.

There are indeed few mathematically minded briliant physicists who have adopted physiology of the muscle and nerve their special subject for research. Professor A. V. Hill, himself a mathematician and physicist, has in this as in his other contributions extended the application of the principles of physics to the elucidation of problems of neuro-muscular mechanism and phenomenon of conduction of impulse along a nerve fibre. This book based on the Liversidge Lecture delivered for the encouragement of research in chemistry is welcomed not only by chemists but also by physicists and physiologists. The ignorance of physicists and chemists, of the most elementary principles of biology which the author mentions in the preface seems to be quite true. The book deals with the nature of the problem and explains some elementary facts about nerves and nerve cells. A considered explanation of the nerve impulse on a physico-chemical basis is offered. It is emphasised that there is no transference of material substance along the nerve fibre during the passage of the impulse; it is to be regarded merely as a message. Since the signs of activity in a nerve usually recognized by the physiologial effects of sensation and response in an entire animal cannot be made use of in the study of isolated nerve fibres, the author describes the electrical change involved in the passage of an impulse in isolated therefore injured nerve fibres. In addition to the electrical change which

is of the order of a few hundredths of a volt, three other accompaniments of activity of a nerve—heat formation, oxygen consumption, and carbon dioxide production—are referred to in detail.

The source of heat produced is considered chiefly from the point of view of an electric disturbance and of surface phenomena. If it is imagined that some molecular change occurs over the whole surface by which energy is set free, the energy per molecule would be very small even compared with that of a quantum of visible light. The energy has been calculated also on the basis of a condenser discharge assuming that films constituting the dielectric of the condenser remaining "impermeable" when it is charged, and is at rest, but becomes conducting, permitting neighbouring areas of the film to discharge through it when once it is itself discharged. The origin of the resting potential is discussed taking the simplest case of a crab's nerve on the differential diffusion theory—potassium ions alone being able to penetrate the surface layer. The possible objections to this theory are considered.

The energy involved in the wave transmission in the nerve is compared to that associated with muscle contraction. The problem of transmission of impulses along the nerve is discussed on the basis of electrical excitation regarding a nerve fibre as a cylindrical condenser with a source of E.M.F. existing in the dielectric between the plates. Experimental evidence is adduced in support of the assumptions made. In dealing with crisis in electrical excitation the author offers to the physical chemists for solution a problem of fundamental importance with regard to the electrical discharge through a film accompanying "a rapid cycle of rise and fall of electrical conductivity".

The other factors concerning heat production are noted whilst suggesting other interesting problems connected with it.

There are the appendices explaining mathematically the excitation of nerve, the measurement of heat production and the energy of a nerve stimulus. There is a good bibliography and the book is well indexed. The author has undoubtedly placed physiologists and chemists under deep debt of gratitude by his lucid exposition of what is obviously a difficult subject.

A. SUBBA RAO.

* * *

ALTERNATING CURRENT ELECTRICAL ENGINEERING. By Phillip Kemp. Pp. xi+595. London: Macmillan & Co., Ltd., fourth edition, 1933. Price 15*sh.*

The fourth edition of this excellent textbook of alternating current engineering is substantially the same as the previous edition, but its value has been increased by the addition of new matter and the introduction of new diagrams. The chapter on transformers has been amplified by the addition of paragraphs relating to tap-changing on load, transformers for very high voltages and other matter relating to recent developments in transformer practice. In the chapter on alternators a revised treatment of armature reaction has been introduced with reference to actual wave shapes instead of sinusoidal waves. The theory of induction motor, already clearly explained in the previous edition, has been amplified and leaves little to be desired. The omission of chapters on transverters and transmission of power makes room for more important matter without any loss to the value of the book. The high hopes once entertained regarding the possibilities of the transverter have not been fulfilled, while the treatment of transmission of power in the previous edition was too sketchy to be of real use. The additional chapter on oscillatory circuits is welcome in view of the immense practical importance the subject has attained in recent years.

The chapter on three-phase commutator motors includes Schrage motor as in the previous edition; brief descriptions might also have been given of other types of motors belonging to the same class. In the chapter on rectifiers we should have liked to see some reference to the recent developments relating to the grid control of mercury-arc rectifiers as it promises to have far-reaching influence on the trend of electrical engineering practice in the future. Symbolic notation has been explained in a chapter at the end of the book. In view of the simplicity and wide use of the notation by other writers it would have been very helpful to the student if this chapter was introduced early and some use made of the notation throughout the book.

We feel sure that this very useful textbook willl remain the favourite of the student for many years to come.

F. N. M.

* * *

Some Aspects of Plant Nutrition.

Rao Bahadur B. Viswa Nath, Agricultural Chemist to Government of Madras, has brought out a booklet on "Some Aspects of Plant Nutrition". It has been issued by the Society of Biological Chemists, India. Rao Bahadur Viswa Nath, who is a man of deep study and long experience, has made his publication interesting and thought-provoking. The subject of plant nutrition abuts on one hand on the subject of soil and on the other on that of animal nutrition. The author has dealt sufficiently with the soils and animal nutrition in order to make his review of the whole subject as complete as possible.

In a small book of about 40 pages it is impossible to go into details of any one of the subjects treated. It was the deep study of Rao Bahadur Viswa Nath that enabled him to condense in a few pages the history of the development of such subjects as soil-colloids, base exchange, soil organic matter, micro-biological population of the soil, the effects of mineral and organic manures on outturns and on the quality of seed produced, auximones and their importance, manuring and nutritive value of crops and the relation of organic manures to animal nutrition. In dealing with each of the subjects he has mentioned all the important work done so far and has at the end of the booklet given a full bibliographical index which will be of great help to the research workers on those subjects.

The booklet is so well written and is so full of information and inspiration that every one interested in the problems connected with plant and animal nutrition should have a copy which is available for one Rupee.

D. L. S.

* * *

Electricity on the Poultry Farm. By L. J. Smith and Harry L. Gawer. State Agricultural College, Pullman, Washington, D. C.

This is a bulletin of 71 pages giving latest and useful information from scientific and economic points of view regarding uses of electricity on poultry farm. The subjects discussed in popular language are poultry house lighting from the point of view of lengthening light during winter months, the beneficial effects of ultra-violet light on egg-laying, candling eggs, time saving and economic use of electrical machines for feed mixers, incubation, brooders, water heating for poultry houses during winter, ventilation with heated air, semi-scalder, control of cannibalism by use of Mazda lamp and refrigeration for storage of eggs. Systems of wiring for general poultry yard lighting and burglar alarm installation are explained. The above are economical when poultrying is done on a ranching scale but not for back-yard poultrying. Refrigeration from the point of view of cooling poultry houses and incubation room has not been worked out, but this aspect is of importance to Indian conditions. It would be interesting for Indian agricultural departments to study this bulletin and work out practical suggestions regarding agricultural machinery and implements for use of the ryots.

T. M.

Coming Events.

Societe de Chimie Physique, 25th Anniversary, October 1933.

General Title: The Electron Theory of Metals—Electrolytes and the intermediate layers, Electrode Solution.

PROVISIONAL LIST OF CONTRIBUTIONS.

1. M. le Professeur Brillouin, College de France, Paris (5°). "Theorie de la Conductibilité des Metaux."
2. M. F. Bloch, Privat-Docent, Institut fur theoretische Physik, 5, Linnestrasse, Leipzig C.1. "Les Electrons dans les Métaux—Propriétés Statiques—Magnétisme."
3. M. le Professeur V. Henri, Universite de Liège. "Energie d'Ionisation et affinité electrique des ions négatifs simples et complexes."
4. M. le Professeur Joffé, Institut Physicotechnique, Sosnowka 2, Leningrad. "Conductibilité des Solides mauvais conducteurs."
5. M. le Professeur E. K. Rideal, Dept. of Colloidal Science, The University, Cambridge. "Phase Boundary Potentials."
6. M. le Professeur M. Volmer, Institut f. physikalische Chemie und Elektrochemie., Charlottenburg, Berlinerst. 171. "Das elektrolitische Wachstum der Krystalle."
7. M. le Professeur P. Debye, Physikalisches Institut der Universitat, Leipzig. M. le Professeur N. Bjerrum, Institut Royal vétérinaire et agronomique de Copenhague, 21 Rolighedavej. Sujet réservé.
8. M. le Professeur P. Dutoit, Université de Lausanne. "Le Potentiel Métal-solution dans les divers solvants."
9. M. R. Audubert, Directeur de laboratoire à l'Ecole Pratique des Hautes Etudes, Institut de Chimie, 11 rue Pierre-Curie, Paris (5°). "Action de la lumière sur le Potentiel Métal-Solution."
10. M. le Professeur F. Dubois, Université de Clermont-Ferrand (Puy-d-Dôme). "L'Effet Volta."
11. M. A. H. Wilson, Emmanuel College, Cambridge. "The electrical properties of semi-conductors and insulators."
12. M. le Professeur A. Gillet, Université de Liège. "Les Colloides et la couche de passage."
13. M. le Professeur O. Scarpa, Milan. "Les différences de potentiel engendrées aux contacts entre métaux par diffusion des ions et électrons. (Pilles métalliques isothermiques).
14. M. le Professeur O. Scarpa (Milan) et M. le Professeur Denina (Turin). "Sur la résistance au passage électrode-électrolyte?"

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An Indian Academy of Science.

GENERALLY speaking the progress of scientific investigation is regulated by the generous enthusiasm of scientific workers and the financial support received from Government or the discerning public. In India it has attained a stage at which further advancement can best be secured by organising and co-ordinating the laboratory operations of official and non-official research departments. Although Indian science should command practically unlimited resources, and actually has enlisted a band of competent and highly qualified investigators, it suffers from inadequate financial support and from the lack of an authoritative exposition of its achievements by a central responsible body which can speak on behalf of her scientific men for India as a whole. The conviction that research is civilisation, and determines the economic, social and political development of a nation has not yet been unreservedly accepted as part of the administrative policy of India, and we are disposed to ascribe the tardy and perhaps unwilling recognition of this fundamental fact to the absence of an all-India scientific organisation whose function would be to concentrate enlightened public opinion on the doctrine that science is material and spiritual wealth. Neither India nor the outside world has at present the means of receiving a complete picture of the total annual output of scientific work conducted under the auspices of Government, the universities and other semi-official centres. Some of the results are found in journals and magazines published by governmental scientific institutions, all-India societies and the universities; but papers of outstanding merit frequently gravitate to foreign periodicals. It seems to us that the early establishment of a National Academy of Science should secure closer and better organised co-operation of activities among all research institutes in India, and exercise through its official journal a wider influence for the consolidation and promotion of the best interests of science.

It is true that individual scientific workers in India have by their indefatigable industry achieved great distinction for themselves, but the prestige of both official and non-official research is still slow in attaining that status of international importance reached

by most European countries. This unsatisfactory position is in our opinion partly due to the tendency of many scientific men to export their more important contributions for publication in foreign journals, with a proportionate impoverishment of Indian archives. Perhaps if the resources of an all-India journal such as we contemplate in connection with the Academy of Science, had been available for giving Indian scientific work suitable international publicity, the outflow of memoirs from this country would have been more restrained and less voluminous. Continuance of this practice will retard the process of building up a scientific tradition for India and keep her in a position of semi-dependence in the world of science. While the foundation of the scientific reputation of a country is established by the quality of work produced in its institutions, the superstructure is reared by the national journals which proclaim their best achievements to the rest of the world. Manifestly the edifice of science in India is incomplete. If scientific contributions from countries which possess national journals are also sent abroad, let it be remembered that they represent a surplus, broadcasting the embellishments of their own national organisations. It is true that the spirit of science and its service are international, but is it not also true that every nation has its own Academies, learned societies, magazines and journals? India will have to organise and develop her national scientific institutions before she can enter into the comity of international scientists. The achievements of Indian science are national assets, and an Academy which treasures and displays them collectively is assured of providing the necessary guidance and inspiration for the younger generation to put forth greater exertions in order to enrich and widen the usefulness of this great estate.

We believe that there will be a general concurrence of opinion supporting the speedy establishment of an Indian Academy of Science with an *Indian Journal of Science* as its official organ for the publication of papers having outstanding merit. Our proposals need not excite any apprehension as to the fate and fortune of the numerous scientific institutions and journals conducted under the auspices of Government, the universities and other unofficial bodies. According to our scheme these will continue to function as before, and the Academy which in some respects may be regarded as their apex will assist rather than assume an attitude of unfriendliness towards them. Government are maintaining six scientific surveys besides ten or more research departments publishing their own journals and bulletins. Nearly all the eighteen universities provide facilities for research and some of them conduct journals. The U. P. Academy of Sciences is the official expositor of research work conducted in the regional universities of the Gangetic valley. The *Indian Journal of Physics*, issued by the Indian Association for the Cultivation of Science, is intended to reflect the scientific results obtained in all the universities. Nearly all the learned societies publish important papers in their journals and some of them have wide circulation. It seems to us that the ground has been thoroughly prepared and the foundation has been laid by these institutions and their organs for the establishment of a central body whose functions will not be permitted to overlap, but will aim at co-ordinating them by establishing cultural contacts. Most of the universities are interested in problems of pure science and through the influence of the Imperial Council of Agricultural Research, their active sympathies are enlisted by a system of special research grants, for the investigation of agricultural topics. The Academy of Science will be an authoritative body of scientists dealing with the more important papers, which they will discuss in their sectional meetings and publish in their proceedings or transactions for which the widest possible publicity will be secured. The scope and purpose of the functions of the Academy are therefore different from those of the Indian Science Congress which offers principally the advantage of human contacts while giving opportunities to discuss the preliminary stages of work still in progress. Thus the aims of the two institutions will be distinct, but complemental.

Among other functions which the Academy will exercise should be included the protection and advancement of the professional interests of its members. It should acquire the necessary authority to advise Government, the universities and other institutions on all scientific matters and other problems referred to it for consideration and to negotiate on behalf of Indian scientific workers with similar institutions abroad. The weight and influence of the Academy may be also most usefully exerted in connection with

there was suggested by him and between the years 1917-19 with the help of Mr. D. S. Bhattacharjee, who was specially lent by the Geological Survey of India, he was able to make a large collection of the remains of sauropodous and theropodous dinosaurs from Jubbulpore and its neighbourhood. The specimens, which are the property of the Geological Survey of India, were studied by Prof. F. von Huene of Tubingen University, one of the leading authorities on fossil reptiles, in collaboration with Dr. Matley. The result of their study, published in the *Palæontologia indica*, has added eleven genera (of which nine are new to science) to the former scanty list of Indian dinosaurs. Of the sauropods, two genera hitherto unknown in India are found; they are the South American genera *Antarctosaurus* and *Laplatosaurus*. In addition, eight new genera of carnivorous dinosaurs and a new stegosaurian genus—*Lametasaurus*—have been established. Of the many interesting facts brought out by the study of these Indian dinosaurs two stand out very prominently. One of them is that all the three sauropod genera of India, *viz*., *Titanosaurus*, *Antarctosaurus*, and *Laplatosaurus* are found in regions so far away as Patagonia and other parts of South America, while remains of *Laplatosaurus madagascariensis*, an essentially Madagascar species, are found at Pisdura in the Chanda district. The other is that the *Antarctosaurus* scapula from Jubbulpore, measuring over 5 feet in length, is probably one of the largest ever recorded in dinosaurs.

Dr. Matley again came out to India in 1925 and collected a number of scattered dinosaur bones from the Cretaceous beds of South India near Ariyalur in the Trichinopoly district.

In November 1932 Dr. Matley, now an aged man of 68 years, started on a fresh expedition under the auspices of the Percy Sladen Trust, with a view to collect reptilian fossils for the Natural History Museum, South Kensington, London. The expedition had the active co-operation of the Geological Survey of India and the services of Mr. A. M. N. Ghosh, B.Sc. (London), A.R.C.S., Extra Assistant Superintendent, were lent to it. The expedition made an extensive tour over the Lameta outcrops in the Jubbulpore and Chanda districts of the Central Provinces and in Rewa State.

The collection from Chanda district consisted of Titanosaurid vertebral centra and broken limb bones picked up from the surface of a ploughed field near the village of Pisdura, and fragments of chelonian carapace and limb bones. Coprolites, big and small, some of them bearing clear intestinal impressions, were also obtained. Excepting two broken limb bones found at Ghunghuti, the Lameta beds in Rewa State did not yield anything worth mentioning. The search for dinosaur remains from the Lameta beds of Jubbulpore district was equally disappointing. The expedition finally met with success at Jubbulpore where excavations were conducted in the green-sand zone of the Lameta series at Chota Simla hill and it succeeded in collecting a large number of remains of sauropodous and carnivorous dinosaurs and a few scutes of an armoured dinosaur. The sauropod remains were represented by the hind and fore limbs of one individual—a titanosaurid, calcaneum and metapodial bones, caudal vertebræ, bones of the pelvis, ribs and hæmapophyses. The more complete of the two femurs was found to be 51 inches long, the tibia and the fibula each measured 32 inches in length and the humerus 36 inches. All the specimens were in a perfect condition of preservation and came from near the junction of the green-sand and the overlying limestone.

The theropod bones were much more difficult to handle. The extreme thinness and spongy texture with the sandy matrix filling up the bony interspaces rendered removal in the field very difficult and identification almost impossible. However, several teeth and ribs were found intact, and a theropod claw, a humerus and scapula were in a good state of preservation. Several theropod vertebræ, two of which were complete with vertebral processes, and a part of a sacrum with three sacral vertebræ carrying a couple of sacral ribs, were amongst the notable finds.

From the above it will be apparent that remains of all the three varieties of dinosaurs were discovered by the present expedition. Want of time prevented further excavation but it is quite likely that more reptilian remains will fall to the efforts of parties engaged in making organized and systematic search of these wonderful creatures, the lords of creation during the Mesozoic era of the earth's history.

securing an adequate statutory provision of grants for all the scientific departments depending on them. Financial stringency is often pleaded as an excuse for diminishing subsidies already insufficient, and although laboratory equipment is expensive, administrative authorities require to be convinced that the price of industrial prosperity is continuous and intensive research. The psychological moment for increasing the research grants appears to be the period when "depressions" overtake the country, for the history of industrial progress testifies that these depressions are due not only to political causes but to a lack of scientific imagination on the part of the industrialists and statesmen. Financial depression is a Handwriting on the Wall, and the only correct interpretation of this message is that scientific research has to be reorganised to cope with the wasteful industrial competition due to over-production. The nation which can foresee and make anticipatory provision is destined to tide over all depressions. It is in such situations that the services of the proposed Academy will be most appreciated, and the knowledge of the scientists will find opportunity for application in the economic, social and political regeneration.

The absence of a central consultative library which imposes a handicap on the progress of research is a subject for consideration by the Academy. At present reference works from the universities are procurable through personal influence, but stringent rules enforced by other libraries reserve the usefulness of the books and magazines to the members of those libraries. The Indian Scientific Surveys lend books and journals to all recognised institutions and scientific workers but the inadequate funds at their disposal must necessarily limit the number of works they can subscribe for or purchase. The organisation of a central reference library under the auspices of the Academy and its administration will necessarily entail a heavy outlay including provision of a suitable building for housing the books and journals. Through its library the Academy will act as a bureau of information to be disseminated among its members. This is the principal direction in which the Academy will supplement the efforts of the existing institutions to further the progress of scientific investigations in the pure and applied branches of knowledge.

The Academy will be a company of thinkers, workers and expounders comprising members of the New Estate upon whose achievements the world must in future depend for the preservation and advancement of civilisation. Their professional spirit must be service, rendered with absolutely no thought of personal advantage. The amount of knowledge they place at the disposal of their country will determine its economic, social and political progress. An Academy of Science is not an ornament, but an indispensable institution for directing the destinies of the nation. We have no hesitation in thinking that its establishment ought to be the natural and legitimate ambition of a progressive government and an enlightened public who should unstintingly provide the institution with sufficient funds for its service in their cause.

Recent Discovery of Fossil Reptilian Remains in the Central Provinces.

DINOSAURS were known to occur in the Cretaceous rocks in Peninsular India as early as 1828, when Major-General (then Capt.) Sleeman collected a few imperfect bones from the Lameta beds of Jubbulpore. Rev. Hislop also made a collection of saurian remains from the surface of a ploughed field at Pisdura, a small village in the Chanda district. In any case nothing much was known about the Indian Cretaceous dinosaurs. As a matter of fact the genus Titanosaur which forms the type genus of the family Titanosauridæ was established by Lydekker from two caudal vertebræ from Jubbulpore.

Prior to 1917 our knowledge of the Indian dinosaurs was limited to a couple of teeth of the carnivorous type and a few broken bones and caudal vertebræ of the non-carnivorous type. No attempt, however, was made to undertake any systematic search of dinosaur remains until 1917 when Dr. C. A. Matley, then Deputy Controller. of War Accounts, an enthusiastic amateur geologist, accidentally came across a limb bone at the Bara Simla hill at Jubbulpore while he was preparing a detailed geological map of that region in his spare time. The possibility of obtaining more dinosaur remains by systematic excavation into the Lameta beds

Lt.-Col. Robert Beresford Seymour-Sewell, M.A., Sc.D., F.Z.S., F.A.S.B., I.M.S., C.I.E.

LT.-COL. ROBERT BERESFORD SEYMOUR-SEWELL, the second permanent Director of the Zoological Survey of India, was born at Leamington, England, on 5th March 1880 and after a very distinguished career of nearly 25 years of service in India has gone on leave preparatory to retirement from 22nd April 1933.

Sewell was a scholar of Weymouth College from 1894-98, and after studying for a short time in the University College, London, joined Christ's College, Cambridge, in 1899. He was in Cambridge till 1905, where he had a very distinguished career first as a student of pure science and later as a medical student. His medical studies were continued in St. Bartholomew's Hospital, London, and after taking the M.R.C.S., L.R.C.P., of London in 1907, he passed the competitive examination for the Indian Medical Service in 1908.

Lt.-Col. R. B. Beresford Seymour-Sewell, M.A., Sc.D., F.Z.S., F.A.S.B., I.M.S., C.I.E.

After serving as a medical officer in the Indian Army for a couple of years, Sewell, in view of his scientific qualifications, was appointed the Surgeon-Naturalist to the Marine Survey of India on board the R.I.M.S.S. "Investigator" in September 1910. In December 1911, he was selected to officiate as Professor of Biology in the Calcutta Medical College and it was not till July 1913, that he resumed his office of the Surgeon-Naturalist. He reverted to military duty on the outbreak of the World War, and saw active service at Aden, in Egypt and Palestine. For a time he also acted as the Health Officer of the Port of Aden, and was mentioned in Despatches for his work during the War. His services were replaced at the disposal of the civil authorities in 1919, and after serving as Officiating Superintendent, Zoological Survey of India, for a year, he reverted to his permanent post of Surgeon-Naturalist. In 1925 he was appointed Director, Zoological Survey of India.

The biological investigations of the Marine Survey of India, which had been carried on for some 35 years when Sewell was appointed Surgeon-Naturalist, had been mainly confined to systematic surveys and making collections of marine faunas, particularly of the deep-sea forms, of the areas visited by the Survey ship. In 1911 Sewell found that the opportunities for deep-sea trawling, etc., were less frequent, and it would, therefore, not be possible to carry out the programme of the biological work on the deep-sea fauna on the lines followed by his predecessors. Quite early in his career he also recognized that there was an almost virgin field of study regarding the physical conditions under which the marine animals live in the tropical waters and he, therefore, started his investigations in detail. The so-far published results of his researches in a special volume of the *Memoirs of the Asiatic Society of Bengal* deal with the geography of the Andaman Sea and the Bay of Bengal, the temperature and salinity of the coastal and deeper waters of the Andaman Sea and the Bay of Bengal. He has also collected material on the oceanography of that part of the Arabian Sea known as the Laccadive Sea and studied in great detail the formation of coral reefs and coral islands in the Andamans, the Gulf of Mannar and the Maldives.

With restricted facilities for pure biological work Sewell concentrated on the littoral fauna and a detailed study of the marine Copepoda. He was the first to use nets for fishing in mid-water and the results obtained by him in 1911–12 showed how highly promising this field for biological work is. Sewell did not neglect the deep-sea fauna, for in 1912 he published a paper on the deep-sea fishes and another in

collaboration with Dr. S. W. Kemp on the Decapods dredged by the "Investigator" during the Survey Season 1910–11.

In connection with the systematic survey of the fresh water molluscs of India, started by the Zoological Survey of India in 1918 at the request of the medical authorities, Sewell published in 1921 a detailed anatomical and bionomical work on the common banded snail—*Viviparus bengalensis*. About the same time he took up the study of the cercariæ which occur in the indigenous fresh water molluscs of India, and this resulted in a number of papers and a very elaborate monograph which was reviewed by one of the leading authorities in the following words:—

> ". . . . The author has given a study of the cercariæ of India that surpasses in extent and thoroughness any study hitherto made of this group in any part of the world. . . . . Suffice it to say that it is sure to be indispensable to all workers in this field."

Since his appointment as Director, Zoological Survey of India, Sewell has published two elaborate monographs on marine Copepods and has also devoted special attention to the biological conditions governing the life of animals in estuaries and in restricted areas of fresh water.

While in Cambridge, Sewell turned his attention to anatomical studies which were of special importance from the biological and anthropological points of view. Prof. Havelock Charles from his studies of the morphology of the lower extremity of the Punjabi adults and fœtal skeletons had concluded that the facets on certain bones of the lower extremity offer a good example of the inheritance of a character acquired by the Punjabi in the evolution of its racial type. Sewell, from a careful study on the *astragulus*, based on the skeletons of Egyptians of the pre-dynastic Nagdah race, of the Fifth Dynasty to the Ptolemaic and Roman period, of Europeans and others, was able to show that the peculiar "facets occur in the fœtus of the European, and probably all other races, whether the facets are found to be present in the adult or not"; he was thus able to disprove the hypothesis of the inheritance of an acquired character as postulated by Prof. Havelock Charles. On the appointment of an Anthropologist on the staff of the Survey in 1927, Sewell was able to revive his early interest in Anthropology and this resulted in a number of valuable contributions on the racial ethnology of the Indians. He also worked out the human and animal remains excavated from the pre-historic site at Mohenjo-Daro and at Mekran; the papers on the human remains were prepared in collaboration with Dr. B. S. Guha, Anthropologist of the Zoological Survey of India.

Sewell was elected a Fellow of the Asiatic Society of Bengal in 1917 and within recent years was awarded the Sc.D. degree of the Cambridge University. He was a Fellow of the Calcutta University (1930-31) and did extremely valuable work in connection with the reorganization of the teaching of Zoology in the University. He was elected President of the Zoology Section of the Indian Science Congress in 1927, of the Anthropological Section in 1929 and was the President of the Indian Science Congress in 1931. In 1930 he acted as the Chairman of the Quinquennial Reviewing Committee of the Indian Institute of Science, Bangalore. He was the President of the Asiatic Society of Bengal from 1930-32 and was awarded the Barclay Memorial Medal in 1932. For his services to the cause of Science in India he was awarded the title of C.I.E. in the New Year's Honours List of 1933.

During his tenure as Director, Zoological Survey of India, Sewell's time was greatly taken up by administrative work and he worked out in detail several schemes of far-reaching importance in connection with the work of the department. Most of these schemes, such as, the erection of a fire-proof spirit building for the reserve collections and offices of the department, an increase in the staff, and the establishment of a marine biological station at Karachi, were administratively approved and it appeared almost a certainty that the department would before long be properly housed, equipped and manned for survey work. Unfortunately, as a result of the acute financial depression during 1931-32, not only were all the schemes of expansion shelved, but very drastic reductions were effected both in the personnel and in the annual budget grants of the department. The same circumstances are responsible for his premature retirement, but it is to be hoped that with the return of normal conditions the schemes for the expansion of the department initiated by Sewell will be revived and that it would be possible to carry out the programme of the work of the department as outlined by him.

Colonel Sewell is personally a very charm-g man, always ready to help his colleagues d assistants in every possible way, and loss to the Zoological Survey, due to his emature retirement, will be keenly felt. rtunately, retirement from service does t mean severing his connection with dian Science, as he has been selected as e leader of the "John Murray Oceano-aphical Expedition" which will be orking in the Arabian Sea from the Persian ılf down to the level of Madagascar, and st to west between India and Africa. In dition to general oceanographical investi-tions the Expedition will pay special attention to the zonation of the fauna on the continental slopes between 50-1000 fathoms and the nature of bottom deposits, while depth-soundings will be carried out in traverses extending over the entire area with a view to elucidating the much-debated land connections or bridges between the two continents in the pre-historic times. His colleagues and other scientists in India will follow the progress of the John Murray Expedition with great interest and sincerely hope that the completed results of his work on this Expedition will bring credit to him and his old department.

B. P.

Silken Shelters of Torrential Insect-Larvæ.*

By Dr. Sunder Lal Hora, D.SC., F.R.S.E., F.L.S., F.Z.S., F.A.S.B.,
Zoological Survey of India, Indian Museum, Calcutta.

THERE is quite a large number of torrential insects, whose larvæ spin thin silken-eets[1] on exposed surfaces of rocks in oderate or swift currents, and, it is presum-l that normally they live underneath them r safety. The silken-shelter is usually ade by covering over a crevice or a groove used by inequalities of the rock surface. ometimes only the groove is bridged over, in *Antocha* and *Elliptera* (Tipulidæ: iptera), while in other cases simple or aborate galleries are also formed extend-ıg in all directions, as in the Philopotamidæ Crichoptera), *Aulacodes* and *Elophila* (Lepid-ptera) and *Charadromyia* (Chironomidæ: iptera). When observed in the natural ondition, these shelters appear very turgid nd well distended, but when taken out of ater they readily collapse. One would e inclined to think that under the pressure f the swift current, the silken sheets would e closely pressed to the substratum, thus ıterfering with the free movements of the nimals beneath them: but in reality this not so, for, as will be seen presently, the wiftness of the current is the main factor hat is responsible for pulling the silken ıeets upwards and thus keeping them roperly distended. Paradoxical as it may ppear, the upward pull on the sheet increases with the swiftness of the current, and thus the animal below it lies in a world different altogether from what its congeners have to face in the open on bare rocks.

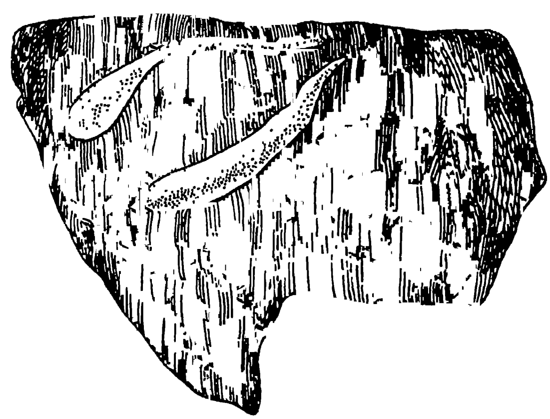


Fig. 1.

Larval shelters of a Philopotamid larva which was found to be very common in a small stream near Peebles, Scotland. The larval cases were found on pebbles and stones in swift current and were covered with a mixture of slime and mud. Notice the elongated nature of the shelters.

The hydraulic principle involved may best be illustrated by analysing the forces of the currents round about the pupal-chamber of the *Aulacodes*. The pupal shelter of the *Aulacodes* is dome-shaped and is provided with openings at both ends in order to permit the free circulation of water below the pupal-chamber (P), as is shown in the accompanying diagram. As the pupal shelter lies firmly cemented to a rock in

* Published with the kind permission of the uperintendent, Zoological Survey of India.

[1] For an account of the silken-shelters of the orrential insect-larvæ see my paper on the Ecology, Bionomics and Evolution of the Tor-ential Fauna" in *Phil. Trans. Roy. Soc., London*, B) **218**, 171, 1930.

swift current, the water glides smoothly over its stream-line body-form. Even so the current at A will be slightly retarded as compared with that at C. But the water that enters the pupal shelter at O flows into the area B, marked with arrows, and in this enclosed area its velocity is greatly retarded. The hydraulic principle to be considered here

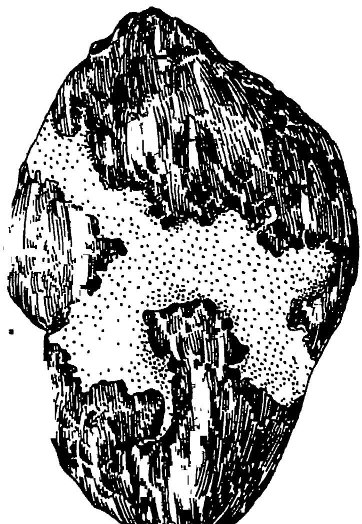


Fig. 2.

Silken-shelter of an *Aulacodes* larva (from a photograph). Notice the extensive galleries that radiate in all directions.

is the same as that which governs the flow of water through pipes. In accordance with this principle, when water flows through a pipe, the sum of the pressure energy $\left(\frac{p_1}{w}\right)$ and the velocity energy $\left(\frac{v_1^2}{2g}\right)$ at one point of the tube is equal to the sum of the pressure energy $\left(\frac{p_2}{w}\right)$ and the velocity energy $\left(\frac{v_2^2}{2g}\right)$ at another point of the tube. By the principle of the conservation of energy, and neglecting frictional losses, the energy at any two points of a tube may be equated as follows:—

$$\frac{p_1}{w} + \frac{v_1^2}{2g} = \frac{p_2}{w} + \frac{v_2^2}{2g} \text{ (per pound of water).}$$

w=weight of one cubic foot of water.
g=force of gravity.
p=pressure.
v=velocity.

Now since the velocity is greater at C (see the diagram) than at B, it follows that the

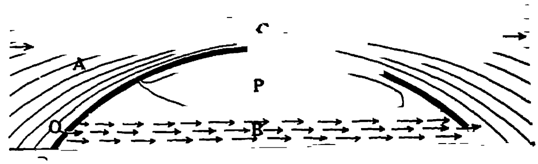


Fig. 3.

Pupal shelter of *Aulacodes* (Diagrammatic, after Pruthi but greatly modified).

pressure at B must be greater than that at C. This means that a 'partial vacuum' is

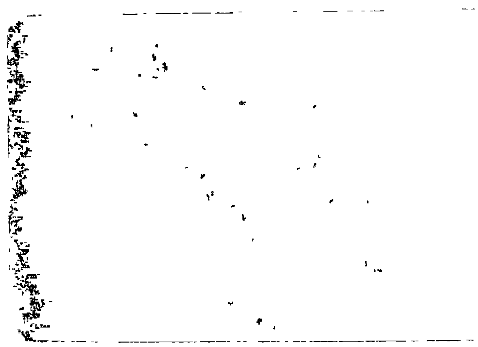


Fig. 4.

A portion of a larval shelter of *Aulacodes* showing a profuse growth of algæ on its upper surface. A part of the shelter is turned over to show the absence of algal growth on the inner surface.

produced at C, which will have the effect of pulling the pupal shelter upwards and thus giving it a dome-shaped appearance. It will also be clear that as the velocity of the current at C increases, the pressure will fall still further at that point, so that the vacuum produced will be stronger. This explanation applies with equal force to the larval shelters also. It is thus seen how, in the economy of life, the forces of nature are usefully employed by organisms.

What is the function of the silken sheets? So far it has been believed that it provides only shelter to the animal concerned. I have myself subscribed to this view. But on a closer examination of the subject, it seems to me highly probable that these devices serve to snare or entangle food particle on which the animal feeds. In this respect the shelters will correspond to the snares of spiders. In the so-called water-spiders, *Hydropsyche* (Trichoptera), that live in conical snares in swift currents, there is no doubt that the shelter is used for snaring

food particles. There are certain Chironomid larvæ which cover the mouth of their tubes with loose-spun silk. This cover acts as a snare for the minute organisms and after a time the larva devours this covering along with the food particles. Similarly, I find that the larvæ of *Aulacodes* feed on the algæ that get entangled in the sticky substance of their silken shelters. The primary function of these shelters then seems to be to act as snares. There is no doubt that they provide a certain amount of shelter to the animal against the swift currents, but it should be borne in mind that the larvæ are capable of living in swift currents without the shelters. For instance, when the larvæ begin to make their shelters, they have to crawl to suitable places and it must take them some appreciable time to make the shelters before they could take refuge in them. Moreover, in *Aulacodes* at least, the larva probably goes on adding galleries afterward, so as to increase the area of its pasture.

This view regarding the function of the silken shelters is further strengthened by the fact that among the brook inhabitants, those that have taken to feeding on microplanktonic organisms, have evolved complicated and ingenious devices to strain minute particles of food out of the rushing current. Among insects reference has already been made to the snares of the *Hydropsyche*,[2] but the fans of Simulium (Diptera), and the bristle-fringed legs of *Chironetes* (Ephemeroptera) and *Brachycentrus* (Trichoptera) serve the same purpose. Reference may also be made to the feeding mechanism of the funnel-mouthed tadpoles of the genus *Megalophrys*.[3] The insect larvæ, like those of the *Aulacodes*,[4] that manufacture silken shelters have no special structural devices for gathering planktonic food, and it seems highly probable, therefore, that the sheets act as snares and thus provide feeding grounds for these animals.

[2] Needham and Lloyd, *Life in Inland Waters*, p. 365 (1916).

[3] Hora, *Rec. Ind. Mus.*, **30**, 139, 1928.

[4] Pruthi, *Rec. Ind. Mus.*

Letters to the Editor.

A Note on the Magnetic Susceptibilities of Cuprous Oxide Films.

WHEN a thin strip of metal is heated by insertion of an edge of it in a bunsen flame, a very thin layer of an oxide film is formed on the metallic surface. The structure of these oxide surfaces has been studied by J. A. Darbyshire[1] and also by W. L. Bragg and J. A. Darbyshire,[2] who have shown by the method of electron diffraction that in the case of copper, the oxide that is formed is of the usual cubic structure of cuprite, Cu_2O. As the composition of the film is a controversial question and the literature describes the film to consist of a mixture of Cu_2O and CuO, it has been considered desirable to examine the question from a magneto-chemical point of view.

The cuprous oxide in the powdered state, when pure and not contaminated with CuO, has been found to be diamagnetic with a value of χ equal to $-0 \cdot 188 \times 10^{-6}$ as determined by the Bhatnagar-Mathur Magnetic Interference Balance. The literature on the subject of the magnetic properties of Cu_2O is highly controversial. For example, the *International Critical Tables*, Vol. VI, page 357, describe the substance to be paramagnetic with a value of $+1 \cdot 2 \times 10^{-6}$, whilst E. H. Williams[3] describes the cuprous oxide to be diamagnetic. Klemm and Schüth[4] have also recently found that Cu_2O has a value χ equal to $-0 \cdot 18 \times 10^{-6}$ and is diamagnetic. This value of the susceptibility of cuprous oxide is in good accord with the figure $-0 \cdot 188 \times 10^{-6}$ obtained by us. Two different samples of Cu_2O, prepared by different methods: (i) by the reduction of alkaline $CuSO_4$ with glucose; and (ii) by the electrolysis of a hot boiling solution of NaCl, between copper electrodes, have been examined by us. In both these cases the Cu_2O was found to be diamagnetic and the values of χ were $-0 \cdot 188 \times 10^{-6}$.

The next step was to examine the films of oxides on copper. They were prepared firstly by heating a clean piece of copper

[1] J. A. Darbyshire. *Trans. Faraday Soc.*, **27**, 675, 1931.

[2] W. L. Bragg and J. A. Darbyshire. *Trans Faraday Soc.*, **28**, 522, 1932

[3] E. H. Williams. *Phys. Rev.*, **28**, 167, 1928.

[4] Klemm and Schüth. *Z. anorg. allgerm. Chem.*, **203**, 104, 1931.

foil as described by Darbyshire and secondly by following the method of Sebatier and Senderens which consists in heating the metallic foil in an atmosphere of nitric oxide to a temperature of about 250°C. A very fine film of copper oxide was formed on the metallic surface, in both the cases. These films are supposed to consist of Cu_2O only and no CuO is supposed to be formed. The films so prepared were removed from the surface of copper by the method employed by U. R. Evans[5] and on investigation were found curiously enough to be definitely paramagnetic, as against the Cu_2O in bulk which we showed definitely to be diamagnetic. There are only two explanations of this behaviour. Firstly, that the film is contaminated with a paramagnetic material, possibly the CuO and secondly, that the magnetic properties of the Cu_2O in film are different from those of the substance in bulk. The second view is not possible on account of the fact that Cu_2O was prepared by different methods and consisted of all sizes of particles. The values of χ however in all the cases of different sizes of particles were nearly always equal to $-0{\cdot}188 \times 10^{-6}$ both in our experiments and in those of Klemm and Schüth. Also in view of the recent work of Lane[6] that the particle size of the film of bismuth has no effect on its susceptibility and that the films examined are paramagnetic, it looks likely that the impurity responsible for the paramagnetism of these films is the production of a trace of the paramagnetic CuO. Further support in favour of this view comes from a recent entirely different investigation of G. Athanasiu,[7] who, in course of his investigations on the spectral sensitivity of photovoltaic piles of copper electrodes coated with Cu_2O, has shown that the presence of a trace of CuO in the sub-oxide tends to diminish the E.M.F. produced by light and also displaces the maximum of sensitivity towards the red end of the spectrum. He coated the plates of copper with thin films of Cu_2O by three different methods and the effects obtained by him are in some cases positive and in others negative, depending on the presence or absence of CuO, as a contamination in the Cu_2O films. According to this author, the films prepared by heating copper in electric furnace contain a good amount of CuO. When these black scales of CuO are removed the positive effect noted above on the photo-galvanic effect of Cu_2O is totally suppressed.

From the magneto-chemical data and the work of Athanasiu it appears probable that the Cu_2O films prepared in the manner described in this paper, contrary to the evidence obtained by Bragg and Darbyshire, consist of a mixture of both Cu_2O and CuO. A fuller account of the work will be presented elsewhere.

S. S. BHATNAGAR.
N. G. MITRA.

University Chemical Laboratories,
University of the Punjab, Lahore,
April, 1933.

[5] U. R. Evans. *Jour. Chem. Soc.*, 2651, 1929.
[6] C. T. Lane. *Nature*, December 31st, 1932.
[7] G. Athanasiu. *Comptes Rendus*, **195**, 767, 1932.

The Presence of Scattered Vascular Bundles in the Stem of *Elatostema sessile*.

IN the vast majority of the Dicotyledons the vascular bundles of the stem are arranged in a ring; hence an observation to the contrary is naturally of interest.

Material of *Elatostema sessile*, a member of the family Urticaceæ, was collected from Mussourie and pieces of stems of various ages were sectioned. It was found that in the greater part of the stem the bundles are irregularly scattered, the larger ones being towards the outside and the smaller towards the centre (Fig. 1). Fig. 2 shows one of

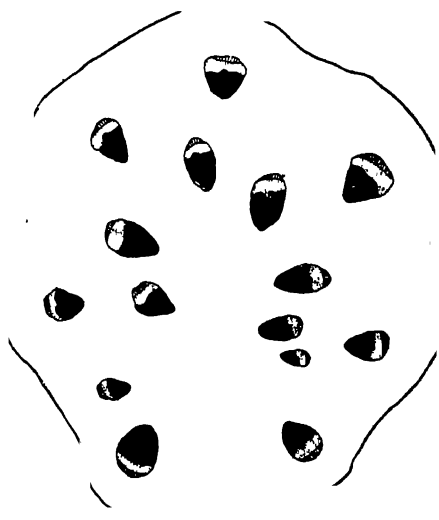


Fig. 1.

these bundles at a higher magnification. It is only at the base of the stem that the bundles are arranged in ring and there is a continuous cambium cylinder with normal

secondary growth. An almost similar condition is known to exist in *Podophyllum peltatum*.

So far as I know, such a behaviour has not been recorded before in the family Urticaceæ. A detailed investigation is in progress and the results will be published elsewhere.

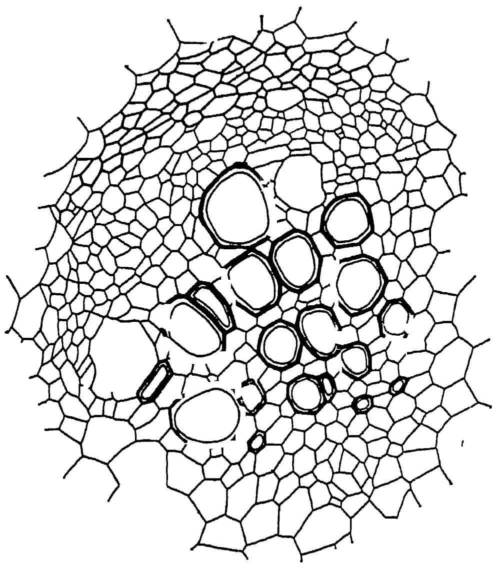


Fig. 2.

The figures were drawn at my request by one of my students Mr. Bahadur Singh, M.Sc.

PANCHANAN MAHESHWARI.

Department of Botany,
Agra College, Agra,
3rd April, 1933.

The Raman Effect of Fused Inorganic Nitrates.

THE Raman Effect of inorganic nitrates in solution and as powdered crystals has been studied by a number of investigators and the normal vibration frequencies of the NO_3 ion, theoretically calculable from a plane equilateral triangular model, are known to be present in the scattered spectrum of these compounds. It is also well known that these free ionic frequencies are modified to a certain extent by the physical state in which the substance is studied. For example, in crystals these frequencies have higher values than in solutions. It will be interesting to study how far the fused state of the substance affects these natural frequencies. With this purpose in view we have investigated a number of inorganic nitrates (whose melting points are below 600°C) in which the Raman spectra are obtained with the substance maintained in a molten condition in a specially constructed electrical furnace. The full report of the investigation is in course of publication and we give below the results obtained with sodium and potassium nitrates only.

	Solution	Crystal	Fused salt
	725	720	715
$NaNO_3$	1048	1066	1054
	1361	1383	1393
	730	711	721
KNO_3	1049	1051	1052
	1357	1350	1343

In sodium nitrate so far as the inactive frequency at $9 \cdot 5\ \mu$ is concerned the fused state occupies an intermediate position between the crystal and the solution while in potassium nitrate this oscillation is apparently uninfluenced by the physical state. This independence of the inactive frequency upon the physical state becomes more and more apparent as the weight of the metallic radical increases. Thus the greatest discrepancy is shown only in lithium and in sodium. With regard to the active frequencies there does not seem to be any systematic variation. The very short shifts observed in crystals and associated with the lattice structure are not obtained in the fused salts.

V. N. THATTE.
A. S. GANESAN.

College of Science,
Nagpur,
April 15, 1933.

Boring Apparatus in Balantidium.

SINCE Ray[1] pointed out the presence of a boring mechanism in *Balantidium sushilii* from *Rana tigrina* Daud, I have examined several other species of Balantidium from the same host and *Bufo melanostictus* Schneid, available in Calcutta. From the accompanying *camera lucida* drawings of

[1] Ray, 1932. "On the Morphology of *Balantidium sushilii* n.sp., from *Rana tigrina* Daud." *Jour. Roy. Micros. Soc.*, **52,** 374-382.

B. elongatum Bezz., *B. helenæ* Bezz., and *B. rotundum* Bezz., it will be clearly seen that such a mechanism is also present in these species and that the borer (*b*) in each case is connected with an axial system of fibres (*ax*). Other fibres which are purely morphonemic in nature, as pointed out by

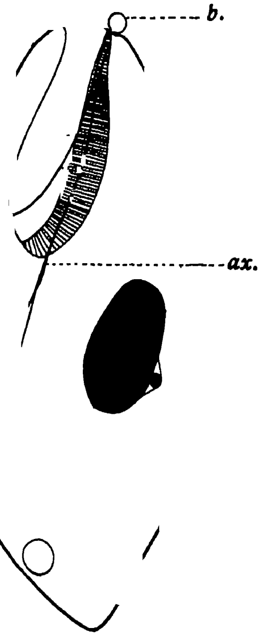


Fig. 1.
B. elongatum Bezz. × 555

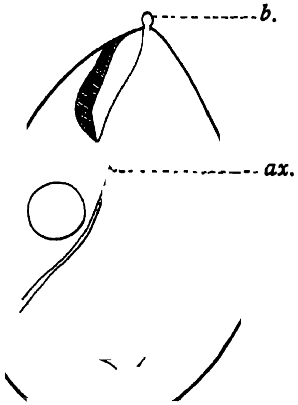


Fig. 2.
B. helenæ Bezz. × 555

Ten Kate[2] are, no doubt, present in these species of Balantidium, but as to the function of the axial system of fibres here, I am inclined to agree with Ray, in suggesting that they have got some sort of motor function as well.

In the cytoplasm of all these species of Balantidium I have also been able to

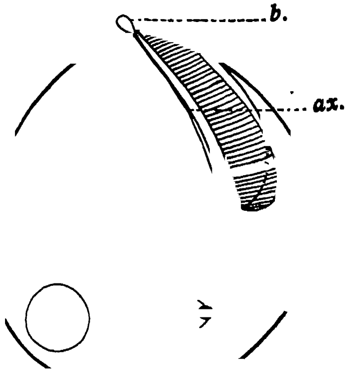


Fig. 3.
B. rotundum Bezz. × 555

demonstrate the presence of red-blood corpuscles by various methods of differential staining.

Detailed observations on these will soon be published elsewhere.

MUKUNDA MURARI CHAKRAVORTI.
Zoological Laboratory,
University of Calcutta,
April 11, 1933.

[2] Ten Kate, 1927. "Uber das Fibrillensystem der Ciliaten." *Arch. f. Protistenk.*, **57**, 362-426.

Influence of Nutrition on Sexual Expression in Maize.

SEEDLINGS of maize grown in moist sawdust were transferred to 6″ pots containing garden soil in early January 1933. In some pots single plants were put, in others 6–8 plants in a ring and in some others 15 or more plants were crowded in together. Most of these started flowering in early April, though they had grown only to a height of 6–8″. Single inflorescences were borne terminally. Single plants in pots developed primarily male inflorescences with one or two female flowers at the base of the inflorescence (Fig. A); overcrowded plants developed female inflorescences with rudiments of male flowers at the tip sometimes, which could only be seen under a dissecting microscope (Fig. C. I–IV); and the plants which had been grown in a ring, *i.e.*, which had not been so much overcrowded usually had inflorescences in which male

and female flowers were fairly distributed—the upper region of the inflorescence bearing male flowers and the lower, female flowers (Fig. B. I–II). Thus, we find that in these maize plants, the inflorescences in single plants which had better nourishment than the crowded ones bear flowers in which maleness predominates and as more crowding takes place, maleness decreases and more female flowers begin to develop and in overcrowded pots where the plants are very much starved female flowers are only formed.

In the overcrowded pots where plants always developed terminal female inflorescences, sometimes an axillary inflorescence would also be found and the latter would also invariably be female ones though of very small size (Fig. C. III–IV).

Kashyap[1] suggested early sowings as cause of abnormalities in maize, *e.g.*, production of bisexual flowers, etc., and Schaffner[2] found maize to be decidedly influenced in its sexual expression by the length of the daily illumination period. Further experimental work on this is in progress and the complete result will soon be published elsewhere.

H. CHAUDHURI.

Lahore,
May 3, 1933.

Dispersion of Polarisation of Raman Lines.

FROM the point of view of the recent theories of the Raman Effect, it would be interesting to investigate whether the polarisation of the Raman line corresponding to a given change of frequency, depends on the frequency of the exciting light, especially when the latter approaches the absorption frequencies of the liquid in the ultra-violet region of the spectrum. Investigations made up to now on the polarisation of Raman lines are confined mostly to the visible region of the spectrum and the results are naturally not sufficient to decide the question. A convenient method of measurement applicable to the ultra-violet region has been developed by me; the polarisation of the well-known 3060 Raman line of benzene, when excited by 3125–32 lines of mercury, is found to be much less than when excited by the 4358 line.

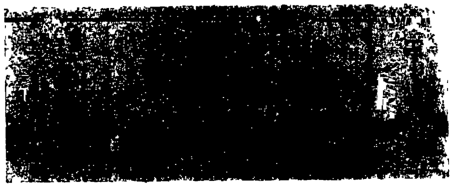
The incident light was made parallel by putting a thick block of wood provided with parallel holes blackened with dull black paint, between the mercury arc and the silica tube containing distilled benzene. No light could reach the tube except through the holes. The maximum angle made by the rays with the axis was about 7°. Photochemical decomposition was stopped by inserting a thin film of glass of special quality between the lamp and the tube and thereby cutting off the ultra-violet rays shorter than 3000 Å. The window of the fused silica tube containing the liquid was painted black, a small rectangular area in the middle being left clean. With a quartz double image prism and a lens, the two images of the aperture due to the vertical and the horizontal components of the scattered radiation were focussed on the slit of a Hilger quartz E_2 spectrograph. In order to correct the polarisation introduced by the quartz elements of the spectrograph for different wavelengths, the silica tube was removed and without disturbing the other arrangements, a small aperture in a black paper, illuminated by a quartz tungsten filament lamp, was placed in the position of that in the window of the silica tube, and the vertical and horizontal components of the continuous spectrum were photographed. All extraneous light was carefully avoided. Intensity marks were taken with the help of the tungsten lamp and by varying the width of the slit which was calibrated with a comparator. Densities were measured with the help of microphotometric records obtained with a Moll's self-registering microphotometer. The relative intensities of the horizontal and vertical components of the Raman lines and of the corresponding wavelengths in the continuous spectrum were obtained from

1 Kashyap, Lahore. *Phil. Soc. Proc.*, 1920, p. 35.

2 Schaffner. *Bot. Gaz.*, 1927, p. 110.

the blackening-intensity curves drawn for these wavelengths.

The microphotometric records of the vertical and horizontal components of the 3060 Raman line of benzene excited by 4358 Å and 3125–32 Å are shown in Fig. 1,



(a) (b)

Fig. 1.

(a) and (b). The line of infinite density is at a distance of 4·7 cms. from the black line. The correction factor for multiplying the observed value of ρ, due to the polarisation introduced by the quartz spectrograph is 1·0 and 0·70 for the 3060 Raman line excited by 4358 Å and by 3132 Å respectively. The vertical and horizontal components of the Raman spectrum and also of the continuous spectrum used for determining the polarisation introduced by the spectrograph for different wavelengths, are reproduced in Fig. 2.

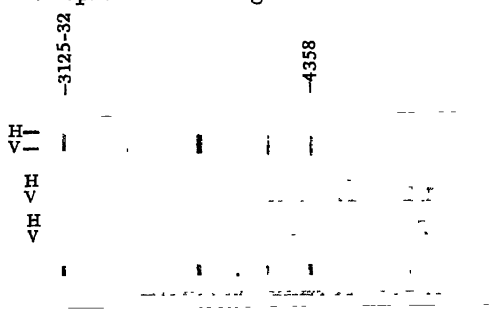


Fig. 2.

The corrected values of ρ for the 3060 Raman line excited by the lines 4358 Å and 3132 Å thus obtained are 0·61 and 0·35 respectively, the former value being almost double the latter. It may be mentioned here that these values of ρ refer in fact to two close Raman lines 3060 and 3046 which are not resolved by the spectrograph used even in the ultra-violet region investigated. (The 990 Raman line excited by the mercury line 3431 Å happens to fall exactly on the 3060 Raman line excited by 3125 Å and therefore does not affect at all the depolarisation of 3060 line excited by 3132 Å.) Details will be published elsewhere.

S. C. SIRKAR.

210, Bowbazar Street,
Calcutta,
May 4, 1933.

The Budde Effect in Iodine.

A PHENOMENON similar to the Budde Effect[1] has been observed when iodine vapour is exposed to light from a tungsten filament lamp.

The apparatus was enclosed in a furnace and pressure changes were observed by means of a glass spring manometer sensitive to 0·1 mm. The photo-expansion was proportional to the light intensity and to the pressure of iodine vapour. By means of filters it was found that at a pressure of 70 mm. the effect was most marked in the violet and orange regions of the spectrum; light of wavelength 500$\mu\mu$ having very little action.

T. S. NARAYANA.

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May 5, 1933.

A Direct Method of Feeding Plants and its Possible Applications in Agriculture and Horticulture.

IN the course of an investigation on the mechanism of synthesis of proteins in *Helianthus annus*, Linn., it was observed that the plants fed with potassium nitrate by an injection method not only tolerated high concentrations of that salt (upto 3·0 per cent.) but also showed considerable gain in dry weight (in some cases as much as 86 per cent.) over the untreated controls in the course of about three weeks. These observations being rather striking, the experiments were repeated in three successive seasons (1930-1932) with similar results.

Although injection methods have been adopted by several previous workers[2] to determine the physiological effects of various chemicals, chiefly those of poisonous nature, and to treat certain deficiency diseases like chlorosis, yet no attempt has so far been

[1] Budde, *Phil. Mag.*, **4**, 42, 290, 1871; also *Pogg. Ann.*, **6**, 477, 1873.

[2] *Vide* Rumbold, C., *Amer. J. Bot.*, **7**, 1, 1920.

made to utilize them to feed plants with various essential nutrients. The technique, as adopted in the past, has also been faulty chiefly owing to the fact that the quantities passing into the plant could not be regulated as in the case of animals. Further researches have therefore been undertaken with a view to developing simpler and, at the same time, more efficient ways of feeding plants directly with different nutrients and to study the application of such methods in (*a*) hastening plant growth and increasing crop yields, (*b*) supplying such plant nutrients and accessories to growth as the root system is unable to collect owing to adverse soil conditions, or otherwise, and (*c*) treating plant diseases, particularly those in which the root-system is already affected or the movement of nutrients therefrom to other parts of the plant is seriously impeded.

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V. SUBRAHMANYAN.
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Bangalore,
May 5, 1933.

Preliminary Observations on Myxosporidia from India.

IT is a well-known fact that a large number of species of Myxosporidia infect fish amongst which they sometimes give rise to severe and fatal epidemics. So, with a view to make a systematic survey of this group which unfortunately is lacking from this part of the world, I examined several fish, amphibia and reptiles brought alive to this laboratory. The only previous observations on Myxosporidia from India are by Southwell[1] in 1915, on a species of Myxobolus from *Rasbora daniconius*; Southwell and Prashad[2] in 1918, on three species of Myxobolus from *Labeo rohita*, *Rasbora daniconius* and an undetermined species Sphærospora from *Barilus barna*, and Bosanquet[3] in 1910, on a species of Myxidium from *Trionyx gangeticus*. In this preliminary communication I wish to place on record several genera with hosts (not noted before from this country) of Myxosporidia from fish, amphibia and reptiles and new hosts for the genera Myxobolus and Myxidium.

Genus.	*Host.*	*Seat of Infection.*	*Locality.*
Ceratomyxa	*Fish*—		
	Gobioides rubicundus	Liver, kidney, ovary, gall bladder, etc.	Calcutta
	Trichogaster fasciatus	Gall bladder	,,
	Macrones gulio	,,	,,
Chloromyxum	Amphipnous kuchia	,,	,,
Cystodiscus	*Amphibia*—		
(=Zschokkella)	Bufo melanostictus	,,	,,
	Rana tigrina	,,	,,
	Reptile—		
	Emyda granosa	,,	Allahabad
Myxidium	*Fish*—		
	Clarias batrachus	,,	Calcutta
	Saccobranchus fossilis	,,	,,
	Ophiocephalus punctatus	,,	,,
	Reptile—		
	Kachuga smithi	,,	Allahabad
	Emyda granosa	,,	,,
	Nicoria trijuga	,,	Madras
Myxobolus	*Fish*—		
	Clarias batrachus	Ovary, liver	Calcutta
	Katla katla	Gills	,,
	Cirrhina mrigala	Liver	,,
	(Myxobolus with unequal polar capsules)		
Henneguya	*Fish*—		
	Ophiocephalus punctatus	Gills and muscles	,,

1 Southwell, T., 1915. *Rec. Ind. Mus.*, Vol. 11.
2 Southwell, T., and Prashad, B., 1915. *Ibid.*, Vol. 15.
3 Bosanquet, W. C., 1910. *Zool. Anz.*, Bd. 35.

Several species belonging to these genera are new and it is hoped that detailed observations on them will soon be published.

In this connection I may add here that infection with Ceratomyxa in *Gobioides rubicundus* proved to be fatal under laboratory conditions. About 50 specimens of Gobioides were placed in a glass aquarium, water of which was changed every 24 hours. After being in this aquarium for some time, a number of specimens began to perish. Changing of water at more frequent intervals was found to be of no avail, and, by the tenth day the aquarium was empty. The first sign of death noted was that the dying ones came up to the surface of the aquarium and floated with their vent upwards. On opening their viscera it was found that almost every organ of these specimens was infected with a species of Ceratomyxa. It naturally suggests that in a running stream the chances for the spores to infect fresh hosts are not so favourable as they are in a confined area of water, and, that once the infection is taken in the parasite works the end of the host no matter how frequently the water is changed.

Pruthi[4] has pointed out that epidemic of fish mortality in the tank in the Indian Museum in 1930 was due to asphyxia. He offers same explanation for the mortality of fish in the same tank reported by Sewell[5] in 1926. Asphyxiation is possible, but at the same time, I wish to point out that the possibility of mortality in fish due to Myxosporidian infection should not altogether be ignored.

Investigations on these lines are now being carried on in this laboratory.

By this communication I also want to invite the attention of zoologists to the economic value of this type of study and earnestly request them to help me either with information or material whenever opportunity arises.

HARENDRANATH RAY.

Department of Zoology,
University of Calcutta,
April 29, 1933.

4 Pruthi, H. S , 1932. *Internat. Revue der ges. Hydrobiol. u. Hydrographic*, Bd. 26.

5 Sewell, R. B. S., 1926 (1927). *Jour. Asiatic Soc., Bengal*, Vol. 22.

Disarmament.

WHEN the proceedings of the Disarmament Conference were resumed, we might have almost prophesied that the delegates of the principal powers in Europe would never reach or evolve a common formula. The peace talks of Sgr. Mussolini and Mr. MacDonald and later of M. Herriot and Sgr. Mussolini and the subsequent conversations of the British Premier with President Roosevelt might have led one to hope that the time was not far off when the harassed world would witness the dawn of peace.

Hitlerism in Germany has become synonymous with Militarism. Under the guise of relieving unemployment, Herr Hitler is proposing to re-arm and train the younger generation for military service. In other words, this is a mild form of conscription and fundamentally opposed to the Treaty of Versailles.

We firmly hold that the proposals for Disarmament will never bear fruit unless the spirit of militarism and the mutual distrust, jealousies and fears are removed. They can disappear only when the European powers become thoroughly Christian in spirit and in deed.

Unfortunately, the problems of Disarmament have become complicated on account of their close relationship with those of economics and from the speeches of Mr. MacDonald and President Roosevelt it is clear that the success of the World Economic Conference depends upon an early and a speedy and satisfactory solution of the questions agitating the Disarmament Conference.

Colonel Sir Rickard Christophers, K.C.I.E., F.R.S., I.M.S. (Retd.)

By Lt.-Col. H. E. Shortt, I.M.S.

IT is one of the anomalies of Government employment that the services of an official are not infrequently dispensed with at a time when his long and varied experience has enhanced his capacity for usefulness to the point of greatest efficiency.

When this applies to a medical scientist of the calibre of Sir Rickard Christophers the loss occasioned by his retirement, both to Government and to the country which has benefited by his researches, is impossible adequately to compute. It is a trite saying that "no one is indispensable" but, in this instance, the gap left is so large that it is difficult to fill.

In a short account such as this it is impossible to do justice to the career of Christophers as a scientist and only a few salient points can be touched upon.

Colonel Sir Rickard Christophers, K.C.I.E., F.R.S., I.M.S. (Retd.)

He received his medical education at Liverpool University, graduating in Medicine in 1896.

Shortly after this he visited South America in a private capacity but his scientific career may be said to have commenced in the year 1898. In the description given below of his activities in medical research the attempt to treat in one section each subject which he has worked at has led to some liberties being taken with chronology but, apart from this, an attempt has been made to describe his work in chronological sequence.

In 1898 he was appointed a member of the Malaria Commission of the Royal Society with Professor J. W. Stephens, F.R.S. and C. W. Daniels who represented the Colonial Office.

There followed four years of intensive work on various aspects of the then new science of Malariology, a science with which, ever since, the name of Christophers has been inseparably identified and, knowing him in later years, one can imagine the ardour with which the task before the Commission was tackled by him, especially as the field was an absolutely virgin one, and not the well-trodden domain it now is.

The operations of the Commission took Christophers over a wide field, speaking both scientifically and geographically. Thus Stephens and he first commenced work in Italy (winter 1898) with Golgi and Ascoli. They then passed to British Central Africa (1898-99) where they were joined by Daniels who remained there while they proceeded to work during 1899-1900 on the West Coast (Sierra Leone, Gold Coast, Nigeria). In March 1901 Stephens and Christophers proceeded to India and continued work there until May 1902.

As the result of their studies Stephens and Christophers gave the first clear account of the conditions of native endemic malaria and all its implications. They described the African village as the reservoir of infection and the fount from which arose the malaria of travellers and expeditions. As a corollary to this they pointed out that the segregation of Europeans was the prime measure of prevention and this principle has ever since been recognized and has been the guiding principle in laying out European quarters in towns and settlements on the West Coast.

They were also the pioneers of "species sanitation" which has of recent years loomed so largely in anti-malarial work and the first clearly do demonstrate the specific behaviour of different species of Anopheles with respect to the nature of their breeding places. For this work Christophers was awarded the Wilhelmina Jubilee gold medal.

This discovery in the field was the direct outcome of antecedent work in the laboratory on the differential characters of the eggs and larvæ of different species of Anopheles which allowed of the separation of species into stream breeders, marsh breeders, pool breeders, etc. Along with this work Christophers was one of the first

to evolve a detailed classification of Anopheles and to describe the larvæ and eggs.

In 1903 appeared the first edition of Stephens and Christophers, "The Practical Study of Malaria and other Blood Parasites" which, for the time of its publication, was an extraordinary mine of information and has been an ever-present help to workers in the field of practical malaria. As evidence of its appeal to European workers it has been translated into French by the Sergents.

With Stephens and Bentley, Christophers was also one of the earliest workers on blackwater fever and experimental hæmoglobinæmia and hæmoglobinuria.

The next period of Christophers' career may be said to have commenced at his entrance into the Indian Medical Service in 1902 and to have extended up to the commencement of the Great War in 1914.

This was a period during which he accomplished an immense amount of original research work which firmly established his reputation as one of the most brilliant workers of the day in the field of medical research. In the space available it is only possible to touch on these researches as a mere catalogue, and even then only the more salient results can be referred to at all.

Malaria has always claimed much of his time and energy and has been the field of some of his most brilliant researches. He was the first to make a really scientific study of malarial epidemics as experienced in the Punjab and to point out and correlate the complex of factors concerned in these conflagrations. This work has been the starting point of all subsequent studies in this field.

In the domain of malarial entomology Christophers has been for years and is still the first authority.

In his later studies on Anopheles he again led the way in distinguishing a number of true varieties of certain species with clear geographical distributions and he is, above all, responsible for the natural classification of Anopheles based on the characters of the genitalia which is now generally adopted among entomologists. This result was only achieved after a very close and detailed study, extending over many years, of the markings and scale structure as well as of brilliant anatomical studies, all of which pointed towards the taxonomic importance of the genitalia.

More recently he has made a close study of acquired immunity in malarious communities. He commenced by studies on the spleen and parasite rates and correlated these with quantitative estimations of the numbers of parasites and the sizes of spleens in such communities. He described a definite cycle of parasitism commencing in early life with a period of acute infestation during which malarial attacks are almost continuous and lasting for two years, followed by a period of immune infestation during which malarial attacks are comparatively rare, especially in adults.

Another domain of research in which Christophers has left an indelible mark is that of kala-azar. He was early in the field and gave the first really detailed description of the pathology of kala-azar and his work on the distribution of the parasite in the human body was so minute and accurate that it was nearly thirty years before any considerable additions were made to his findings. Considering the little known of kala-azar at the time and the amount of work expended on it later this is an astounding statement to be able to make. He also gave an accurate description of the parasite as it occurs in the vertebrate host and was the first to confirm Rogers' finding of the flagellated cultural forms of *Leishmania donovani*.

One other piece of work performed by him over twenty-five years ago and which has remained ever since the only authoritative account has recently been confirmed, *viz.*, his account of the life cycle of *Babesia* in the tick. Recent researches on *Babesia bigemina* of cattle and its life cycle in the tick *Margaropus annulatus* have confirmed Christophers' early work on *Babesia canis* and its life cycle in the dog tick *Rhipicephalus sanguineus* during the course of which he worked out carefully the anatomy and histology of the tick and traced, in this connection, the hereditary transmission of *B. canis*.

In 1916 Christophers was caught up in the tide of the great war and proceeded to Mesopotamia. There he founded the Central Laboratory, Busra, and became its Director and Chief Malaria Officer to the Mesopotamian Expeditionary Force. Here he quickly showed that the scientist of the laboratory could become the practical army sanitarian in the widest sense of the term, without any transitional stage. For over three years he directed the Central Laboratory at Busra

besides making numerous tours throughout the area of hostilities. In this laboratory he was responsible for the building up of an organization which was able to answer any scientific queries from Army Headquarters whether these related to malaria, chemistry, bacteriology, entomology, protozoology, general sanitation, food supplies or clothing.

The recrudescence of kala-azar in Assam led, in 1924, to the formation of the Kala-azar Commission financed by the Indian Research Fund Association. Of this Commission Christophers was, with unanimous approval, appointed Director and so came once more to grips with a disease with which, in the early days of its study, he had been associated as one of the chief investigators. He remained Director for over a year and, having successfully launched the Commission, laid down lines of work which subsequent experience proved to be the soundest possible.

Christophers was next appointed Director of the Central Research Institute, Kasauli, and so became the responsible adviser to the Government of India on medical scientific matters. About the same time he was honoured by being elected a Fellow of the Royal Society, a fitting reward for his services to science.

He finally retired from India in 1932, happily in the full enjoyment of health which will enable him to continue in the pursuit of those studies which have been to him a recreation rather than a burden.

As regards Christophers' outlook on science he was one of those who believed in basic research as apart from direct utilitarian research. In other words, he considered that the subsidizing of research led inevitably to the necessity for producing so-called useful results. He considered that the best and highest type of research was that done in the pure quest for knowledge without previous consideration of where the knowledge would lead and whether it would be of immediate useful application or otherwise.

Having given this altogether inadequate description of Christophers the scientist, it remains but to say a few words of Christophers the man. The last word of the preceding paragraph adequately describes him. He is a man in the best sense of the word. His humanity is so large and so all-embracing that the writer can think of no other scientific worker who was so universally beloved by all those with whom he came in contact, so that the gap left by his retirement from India is not felt in the scientific sphere alone.

This account of Christophers cannot be closed without mention of an influence the full extent of which we cannot gauge, but which he himself would acknowledge, played a great part in his successful career. Lady Christophers, beloved equally with him by all their friends in India, was to him a constant source of encouragement and both carry with them the sincerest wishes of these friends for success and happiness in their new sphere of activities.

Acknowledgments.

WE have pleasure in announcing that the Council of the Indian Institute of Science have awarded a grant of Rupees Five Hundred for *Current Science* for 1933–34. The Syndicate of the University of Madras continue their subsidy of Rupees Five Hundred for the next year. The Executive Council of the University of Nagpur have sanctioned Rupees One Hundred in response to our appeal for funds.

We take this opportunity of recording our deep sense of thankfulness to all these authorities for encouraging so readily the cause of scientific journalism in India.

With the next number of *Current Science*, the journal will complete the first year of its career. *Current Science* occupies a distinct position and fulfils a definite purpose in the scientific progress of India. We had hoped that this enterprise would receive the unstinting support of the Governments, the Universities and the enlightened public so as to relieve the financial anxiety inseparable from all such ventures. It is true that financial depression exists in the country. But we doubt the wisdom of pleading this as an excuse for withholding assistance to a journal which serves not only the interests of Science but leads the way to the general progress of the nation Viewed from this broader standpoint we have no hesitation in thinking that in the forthcoming years *Current Science* will receive the enthusiastic support of all who are placed in a position to render it, for the promotion and diffusion of scientific knowledge.

Some Obscure Aspects of Nutrition.

By N. C. Datta, M.Sc.,
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THE discoveries of the past few decades have brought to light the importance of what Mendel, in 1923, described as the "little things" in nutrition. The more recent studies on the physiologically active principles of grandular secretions and of vitamins have not only brought into prominence the rôle of various hitherto neglected entities in nutrition but have also vastly modified our ideas of dietetic requirements. There is one important aspect, however, which has not so far been properly understood and it is the object of this paper to lay stress on its significance particularly to India where the articles of diet, as also the mode of cooking, spicing and storage are different from those generally adopted in most other parts of the world.

It has long been believed that traces of various metals, particularly aluminium, copper, manganese and zinc occur regularly in the animal body but it was not until recently that their presence could be confirmed. Owing largely to want of adequate technique for the identification and analysis of minute quantities of different metals, the investigators had unfortunately long been divided in their opinion regarding the very existence of such substances in the animal body. Later work, however, has not only confirmed their presence but has also shown that they occur in varying concentrations in different parts of body, that they are present in different articles of food and that they are metabolised in the animal system in a manner similar to that of other constituents of food. Their rôle in the animal system and their relation to conditions of health and disease have, however, so far remained obscure.

During recent years, the problem has assumed an increasingly important and conspicuous position in the human environment due to the cheap production of metals and alloys and increased use of metallic containers for cooking and storage. This tendency is particularly prominent in India where even in the country-side metallic ware, particularly brass, bronze and aluminium are steadily ousting the traditional earthenware utensils and this, unfortunately, too often irrespective of the nature of food materials prepared.

In many parts of India the average diet of the people is characterised by the presence of large quantities of organic acids, particularly tartaric, citric and lactic, together with quite considerable amounts of salts, chillies and spices to buffer the taste. Dhal, vegetables or meat are cooked in such media and the preparations thus made as also various types of pickles and preserves are stored for varying periods of time in metallic vessels. Different fermentation processes, chiefly lactic, calculated to improve the taste are also allowed to proceed in metallic containers, so that the present problem, particularly in India, is not so much one of determining the role of minute quantities as that of ascertaining the consequences of taking fairly large quantities which may be reasonably expected to pass into the every-day diet of the vast population of the country.

The literature that has accumulated of recent years is not very helpful to the elucidation of the present problem. Firstly, a large part of the earlier research was directed towards determining the effect of traces, and secondly, no systematic experiments were carried out in presence of organic acids and salts and under conditions prevalent in most parts of India. The previous observations are all the same of considerable intrinsic value and some of them have been cited below to indicate the general progress in the subject.

Aluminium.—Longworthy and Austin (1904), Meyer and Voegltin (1914), Gonnerman (1918) and Bertrand (1920) have reported significant amounts of aluminium in a long list of plant and animal foods. Osborne and Mendel reported better growth in white rats from diet containing protein-free milk to which a little aluminium had been added. On the other hand, Gies and his co-workers (1916) adduced evidence to show that aluminium compounds when present in the diet are absorbed out of gastro-intestinal tract and carried into the blood stream with harmful effects. To settle the question the Referee Board of Consulting Scientific Experts of which Ira Remsen was the Chairman, studied the effect on human subjects and concluded that the residue present in biscuits baked with baking powder containing sodium aluminium sulphate has no harmful effect on metabolism.

The possible rôle of aluminium in nutrition has been recently discussed by McCollum, Rask and Becker (1928). These authors observed no noticeable difference in a period of approximately six months as regards growth, reproduction and general well-being between the controlled rats and the animals fed at a level of 0·6 per cent. of aluminium chloride. The same authors using a Hilger Quartz prism spectrograph failed to find aluminium in a number of substances in which it had been reported to be present and concluded that aluminium is not a constituent of either plant or animal matter. On the other hand, Kahlenburg and Closs (1929) using the same method reported aluminium in egg, tomato, carrot, meat and a number of other articles of food. In a like manner Wright and Papish (1929) detected aluminium in the ash of milk.

Meyer and his co-workers (1928) adduced evidence of a small but fairly constant amount of aluminium in the tissues of dog, rat and man. Meyer and Morrison fed dogs at a level of 0·23 to 1·55 g. of aluminium and found an average of 0·27 mg. of the metal per 100g. of liver as compared with 0·15 mg. of aluminium in control animals. No marked increase of aluminium was observed in any other tissue. Meyer and Mull interpret the low percentage in the tissues after prolonged aluminium feeding as indicating poor absorption.

There is abundant evidence of the occurrence of small amounts of aluminium in food and in animal tissues, but no clear-cut evidence as to whether such minute quantities have any specific function. The effect of aluminium in fairly large quantities such as obtained when preparing some Indian food-stuffs, storing pickles, curdling milk and such like operations has yet to be investigated.

Copper and Iron.—Bodansky (1921) found copper in adult brain to the extent of 3·6 to 6 mg. per kilogram of brain material. Warburg and Kerb (1927-28) have reported copper in human blood serum. McHargue (1926, 1928) states that no product of either vegetable or animal origin is free from copper. Bertrand (1920), Supplee and Bellis (1922) agree that both cow and human milk regularly contain copper and that in the case of infants as well as adults copper is absorbed from the alimentary tract as proved from its constant presence in urine. Thus, an infant three months old excretes 0·02 mg. of copper in urine, an adult on low copper diet 0·08 mg. per litre and one on high copper diet 0·11—0·14 mg. per litre.

Von Bunge was the first to show that milk is deficient in iron. Abderhalden (1900) demonstrated that animals kept on prolonged milk diet develop anæmia with marked decrease in hæmoglobin content and that increase in inorganic iron did not result in an increase of hæmoglobin content. Hart, Steenboch, Elvehjem and co-workers (1928) observed that the effect of addition of 0·25mg. of copper daily as copper sulphate and 0·5 mg. of iron as ferric chloride to a whole milk diet was immediate and striking in regeneration of hæmoglobin in rats made anæmic with whole milk diet. This is the first experiment in literature attributing to copper in association with iron the specific function of hæmoglobin regeneration in a mammal on otherwise satisfactory diet.

During the past four years, two schools of thought concerning the inorganic factor which influence the regeneration of hæmoglobin in rats made anæmic by feeding on whole milk have developed.

1. Hart and co-workers (1928), Underhill-Orten, Lewis (1931, 1932), and Keil and Nelson (1931) maintain that copper alone of all metals studied has the ability to supplement iron in curing nutritional anæmia in rats.

2. Mitchell and Schmidt (1926), Robsceit, Robbins and Whipple (1929), Drabkin and Waggoner (1929), and Meyer and Beard (1931) maintain that iron alone is effective in curing nutritional anæmia in rats though traces of other metals may have a helpful influence.

In spite of the several apparently contradictory statements on the subject, the general evidence would suggest that copper so widely distributed in the animal body and so definitely a constituent of liver must be regarded as an element of importance in iron metabolism in nutritional anæmia.

Copper taken in excess, however, has poisonous effects. Mallory announced that vegetable foods prepared in copper vessels are coloured green with copper salts and is the cause of the disease popularly known as hardening of liver. Chronic copper poisoning is a more common disease than has been thought of. Copper starts its action by causing red-colouring matter of blood to decompose forming a yellow pigment, a phenomenon which Mallory calls Hemochromatosis. Chronic copper poisoning may be slow in making itself felt but its effects,

direct as well as indirect, may be far more serious than has hitherto been suspected.

Zinc.—The occurrence of zinc in plant or animal matter seems to be nearly as general as that of aluminium, copper or manganese. Lutz estimates the total amount of zinc in the body of a man weighing 70 kilograms is about 2·2 g., *i.e.*, nearly as much as the amount of iron as estimated by Sherman (2·8 g.)

Drinker, Thompson, Marsh (1927) fed dogs and cats for periods of 3 to 33 weeks with daily doses of 175 to 1000 mg. of zinc as zinc oxide without any ill effects. Rats given from 0·2 to 3·8 mg. of zinc per day as zinc oxide grew normally and their offsprings reared successfully. The concentration of 0·038 to 0·04 mg. of zinc per gramme of tissue is maintained constant regardless of age.

Fairhill studied zinc excretion in man on ordinary diet and found the average amount passing into excretion, urine to be 1 mg. per day. The quantities passing into the fæces varied greatly, being directly influenced by the amounts ingested.

The rôle of zinc in normal nutrition has been discussed by Hubbell and Mendel (1927). These authors observe that with a supplement of 0·005 mg. of zinc per mouse per day on a diet adequate in vitamins, there was definite retardation of growth, but with 0·02 mg. of zinc per day per mouse there was better growth. Hence the authors concluded that there is a variation in growth with varying amount of zinc and that the metal is not an accidental factor in the nutrition of mouse.

Salant and his associates (1920) observed that when taken by mouth zinc is not very injurious. It is absorbed from the intestinal canal which is also the main channel for elimination. It is stored in considerable amounts in the liver.

Tin.—Moderately large doses given daily for long periods of time may prove harmful to health. The metal is rather slowly absorbed from the intestines because of the insolubility of many of its salts.

Manganese.—Manganese appears to be present in most living tissues, both animal and vegetable.

McCarrison (1927) noted that wheat was relatively rich in manganese as compared with rice and other food grains. He experimented with two groups of rats, one receiving 0·56 mg. of manganese daily and the other 0·009 mg. Both the groups of animal continued throughout in apparent good health. The group with the larger dose did not grow quite as well as the control one on adequate diet without manganese added, but the difference seemed scarcely significant. The basal diet itself contained traces of manganese.

According to Titus, Cave and Hughes (1928), the manganese-copper-iron complex is most active in hæmoglobin regeneration.

The above survey would suffice to show that very little definite information is available with regard to the rôle of different metals in either small or big doses. As the study of the effect of large doses is of considerable importance, particularly under the conditions prevalent in India, a systematic investigation of that aspect of the problem has been undertaken by the author and his co-workers. The immediate object of the study would be to determine the effect of preparing different articles of food (particularly those containing large amounts of organic acids and salts), acid drinks and butter-milk in aluminium and brass vessels (tinned or otherwise) and finally to study the effect of corrosion of the metallic cooking vessel during the preparation of different foodstuffs under conditions in actual practice in India. A parallel set of experiments under similar conditions will also be conducted to determine the quantities of metals which can be tolerated and stored in animal tissue without any harmful effect. The effect of the corresponding quantities of different metals on the growth, reproduction and general well-being of animals for several generations will also be elucidated by actual feeding experiments. It is not, however, to be presumed that a limited number of experiments conducted by a small number of workers will be sufficient to throw any definite light on this fundamental problem. It is earnestly to be hoped, therefore, that similar researches will also be undertaken in other parts of the country and elsewhere in the world under conditions prevalent in different areas so that, at the end of a certain period, the various observations may be pooled together and some definite conclusions drawn. The organization of such a research on a large scale basis would indeed be difficult, but in view of its fundamental importance it is hoped that the Indian Research Fund Association as also International Organizations like the Rockefeller and the Carnegie Foundations would take interest in the problem and render the necessary moral and material assistance.

With such efficient organization on the one hand and keen public interest in the progress of the researches on the other, it is not too much to hope that before long some fundamental conclusions leading to the evolution of newer and more balanced dietetic schemes and further betterment of public health would be reached.

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Atomic Nucleus and the Hyperfine Structure of Spectral Lines.*

By Prof. B. Venkatesachar, M.A., F.Inst.P., *Central College, Bangalore.*

THE end of the nineteenth century saw the climax of what is to-day known as Classical Physics. The work of Maxwell and Faraday and Fresnel and Young based on the foundations laid by Galileo and Newton appeared to be a splendid structure almost without a flaw. However, there were a few misfits, like the distribution of energy in the spectrum of a black body, which troubled master-minds like Kelvin and Rayleigh. The brilliant theory of Planck, advanced in 1901, questioned for the first time the foundations of classical physics and the photo-electric equation advanced by Einstein jeopardized the whole structure.

Meanwhile, a large amount of experimental knowledge was being collected by improved experimental technique. The structure of the atom had been engaging the attention of the leading physicists and Thomson had propounded his theory that the atom is constituted of electrons imbedded in a spherical positive charge. Rutherford's experiments on the scattering of α-particles established the fact that the α-particles could pass through atoms and suffer large deviations, and this led to his famous nuclear theory of the atom. In 1913 Bohr formulated his celebrated theory of the hydrogen atom, attributing to the revolving electron angular momenta which were quantised and thus restricted the possible orbits. Soon after, he explained the spectrum of ionised helium and showed how the differences in frequency between the helium lines and the alternate hydrogen lines could be explained by taking into account the fact that the mass of the electron is not negligible compared to that of the nucleus. Bohr thus brought order into a large mass of empirical data regarding the emission lines of hydrogen and helium. Sommerfeld extended the theory by including elliptical orbits, thus attributing two quantum numbers, azimuthal and radial, to any orbit. The relativity variation of the mass of an electron in an elliptical orbit due to varying speed in the orbit was found to explain the fine structure of spectral lines.

One important corollary from Bohr's theory was that by exciting the atoms or molecules and thus raising the ground-level electrons to higher states of energy, absorption of lines not absorbed by the normal vapour could be effected by the incidence of the suitable light quantum. This important conclusion has been verified by the experiments of Metcalfe and Venkatesachar (*Proc. Roy. Soc.*, **A 100**, 149, 1922 and **A 105**, 520, 1924) who showed large selective absorption in mercury vapour by the device of double arcs, one very weak and long and the other very strong, the latter acting as the source.

A very large amount of work has been accomplished in the study of the emission spectra of various elements. It must be remembered that these lines result from the various ways of internal arrangement of the loosely bound or valence electrons. Also we must distinguish the emission spectra of neutral atoms from those of singly ionised or multiply ionised atoms. In the case of the alkali elements, for example, there is only one valence electron and the study becomes simpler. The total quantum number (n) of this electron orbit in the lowest state is 3. There are three more quantum numbers associated with the electron: l (which is always equal to $k-1$, where k is the azimuthal quantum number), s, the spin quantum number and j which is $l \pm s$ (*i.e.* $l \pm \frac{1}{2}$

* Summary of six lectures delivered at the Annamalai University, Annamalainagar.

for the one electron system we are here contemplating). In the case of an atom having any number of valence electrons, the l's of the several electrons are vectorially combined into a resultant L and the spins into a resultant S and J is obtained as the resultant of L and S. In the presence of a uniform external force field, each electron is characterized by five quantum numbers, *viz.*, n, l, s, m_1 and ml. According to the celebrated theoretical physicist, Pauli, these five quantum numbers cannot be identical for two or more electrons; this assumption gives a natural explanation of the short and long periods in the periodic table.

With improved experimental technique, spectroscopists soon found that the several lines of a multiplet whose origin is usually attributed to electron spin showed a hyperfine structure, the separations herein being much smaller than those due to the spin of the extra-nuclear electrons. For the experimental study of the hyperfine structure of elements like cadmium, cæsium and thallium, the method described by Venkatesachar can be adopted. The cathode in the vacuum arc is a 2% amalgam of the element. By cooling the arc, the lines may be obtained extremely sharp and without self-reversal.

Very great care has to be exercised in the experimental technique; otherwise, spurious results may easily occur. The line width of the satellites has to be arranged to be small enough so that separations can be observed easily. It has been shown by Venkatesachar (*Phil. Mag.*, **49**, 33, 1925) that the half-width of a line $w = \sqrt{\frac{\log 2}{k}}$ where $k = \frac{M}{2R\theta}\frac{c^2}{\lambda^2}$. It follows that w can be greatly reduced by decreasing θ, *i.e.*, by working at very low temperature, *e.g.*, by using liquid air around the cathode. By using long columns, the relatively greater absorption of the central parts of the satellites will result in their widening and thus decrease the resolvability of two neighbouring lines. This might even result in a self-reversal along the middle of the line. Such was indeed found to be the case with electrically excited cadmium vapour for 4800 Å. However, long columns are useful in the study of weak lines which are not markedly absorbed. The Lummer-Gehrcke plate is most frequently used in the study of the hyperfine structure of spectral lines. There is the danger of the appearance of ghosts even in the best-made plates and special care has to be taken to distinguish the true from the false lines. Fused silica etalons have also been recently used in the study of hyperfine structure and Venkatesachar and Sibaiya (*Jour. Sc. Inst.*, **9**, 216, 1932) have shown their advantages particularly in the observation of faint satellites.

The usual theory advanced for the hyperfine structure is that the nucleus of the atom has a quantised rotation with a quantum number i which, with the inner quantum number j, gives fine quantum numbers of the sub-levels ranging from $j+i$ to $j-i$. The selection rule laid down by Hargreaves suggests that during a transition this quantum number changes by 1 or 0. Ruark and Chenault have suggested that the small quantised variations of the configurations of the outer shells cause small changes in the energy levels of the valence electron. Schüler and Brück postulate the existence of zero moment in the case of even atomic weights and ½ in the case of odd atomic weights amongst the isotopes of cadmium.

When the magnetic moment of the nucleus is deduced from the magnitude of the hyperfine separations it comes out to be of the order of 1/2000 of a Bohr magneton. This fact suggests the annihilation of electron spin within the nucleus. A good part of this difficulty, however, can be overcome if we assume with Venkatesachar and Subbaraya (*Current Science*, **1**, 120, 1932) the existence of only α-particles, protons and neutrons within the nucleus.

"A large amount of work yet remains to be done. The theory of hyperfine structure is still in its infant stage and the subject offers the greatest scope to all investigators, not only from the point of view of the difficult experimental technique involved but also from the fact that a thorough knowledge of the complicated structure is necessary for a correct understanding of the most fundamental problems of modern physics."

The World Economic Conference.

ON the 16th of June about 2,000 delegates drawn from all countries will meet in London to discuss the economic problems which now confront every nation and seem to challenge a satisfactory solution. We are satisfied about the representative character of this large assembly and considering the magnitude and the intricate complexities of the issues that will come up for discussion, we venture to doubt whether in the multitude of counsels any satisfactory formulae will be evolved. The world suffers now not so much from want of agricultural produce or manufactured goods but curiously from an excess of both, and the marketing facilities have been restricted by high tariffs and narrow protectionist policies. The removal of any of these alone, even if it is possible, may not alleviate the economic depression; for vested interests and capitalism are not likely to be removed at one or even a series of sittings of economic conferences. Perhaps a smaller body of scientists, industrialists and bankers would be able to deal with these problems in a more efficient, and possibly, in a permanently satisfactory manner than a large concourse of politicians can hope to do. Scientists possess both knowledge and executive power which, when supplemented by the practical experience of economists and financiers, will become a power for the removal of all those ills with which the social and economic life of the nations is afflicted. However, we hope that the efforts of the Economic Conference for the spread of peace and contentment in the world will be crowned with success.

Research Notes.

Line Groups and Fine Structure.

[F. Paschen, *Ber. d. Preuss. Akad. d. Wiss*, **32**, 3, 1932.]

IN this paper Paschen considers the effect of hyperfine structure on the lines of a multiplet when the hyperfine separation is of the same order of magnitude as the gross multiplet separation. The effect is shown to be similar to the Paschen-Back magnetic transformation of a multiplet, but here the magnetic field is provided by the nuclear spin. Accordingly, the positions and intensities of the multiplet lines are disturbed and forbidden transitions belonging to the multiplet are produced; since each of the multiplet lines is also split on account of the hyperfine structure, the whole group of lines shows a structure which is due neither to simple gross multiplet separation nor to pure hyperfine separation of the multiplet lines. In this way the unaccounted doubling of the levels in the spectrum of Al II which Paschen had previously discovered is explained. Multiplets are also considered in which the hyperfine separation predominates over the fine separation, *e.g.*, the $4^3P_{2,1,0}$—5^3D_j group in Al II. It is shown that in this case the j value of the 5D term is not determinable since the term acts as a $^3D_3$ term in its combination with $^3P_2$ but behaves like a $^3D_2$ term in its combination with $^3P_1$. From these observations as well as the experiments of Ritschl, Paschen concludes that the Al nucleus has a spin of $\frac{1}{2}\frac{h}{2\pi}$. The displacement of the components of the hyperfine structure pattern of λ 5791 found by Schüler and Jones is also to be explained according to Paschen on the above lines since here the difference between $^3D_1$ and $^1D_2$ of Hg I is only 3 cm.$^{-1}$ while the hyperfine separation of the levels is about $\frac{1}{7}$ of this. The appearance of the forbidden transitions 6s 6p $^3P_0$—$6snd$ $^1D_2$, $n=6, 7, 8$ in Hg I is also accounted for as an effect of the nuclear moment. A continuation of these investigations is also promised.

Nitrogen Recuperation in the Soils of the Bombay Presidency.

[Part III. By D. L. Sahasrabudhe and N. V. Kanitkar. *Ind. J. Agric. Sci.*, **2**, 455, 1932.]

THE above is the third of a series of contributions by Sahasrabudhe and his co-workers to a problem of fundamental importance not only to Deccan but also to the rest of the world in general. The authors claim to have obtained definite evidence of nitrogen recuperation on the dry farm tracts which they investigated. The recuperation is facilitated by (1) wetting by monsoon followed by dry weather, (2) better cultivation, and (3) addition of organic matter in the form of farm-yard or green manure. Soil moisture and temperature are important factors determining the efficiency of the process, the optimum conditions being 20 per cent moisture and 30° C. The authors conclude that the nitrogen content of the soil is not a stable or constant quantity. There is a range for every soil which is determined by various factors, such as, moisture, temperature and aeration, which, again, are dependent on the prevalent climatic conditions.

The paper is unfortunately defective in some respects. Thus, no mention is made of the errors of (1) random sampling from the experimental area, and (2) analytical methods employed. It is not clear from the text as to how many specimens were analysed at a time but the results would have been far more valuable if the different representative samples had been analysed independently instead of being mixed together. It is hoped that the above defects will be eliminated in later publications.

Double Hydropore in the Development of *Asterias glacialis*.

IN this paper Dr. N. Narasimhamurti (*Journ. Exp. Biol.*, **10**, No. 2, 1933) observes that the addition of sodium chloride to the sea-water in the proportion of 38 grms. per 1000 cc. produces double pored larvæ of *A. glacialis* in greater numbers than is the case in ordinary laboratory cultures. The author is of the opinion that this increase in the number of abnormal larvæ in the hypertonic cultures is the result of the addition of salt, quite early in the development and that it acts as a stimulus to the growth of the larvæ equalising the difference between the right and left larval halves thus producing a right hydropore.

A New Method of Producing Extremely Low Temperatures.

(F. Simon. *Physikal. Zeitschr.*, **34**, 232, 1933.)

IN the reports of the Proceedings of the Thüringian-Saxonian section of the German Physical Society which met at Breslau on the 8th and 9th January 1933 a new method of producing liquid helium is described. The principle is extremely simple. A small vessel filled with helium at about 100 atmospheres pressure is cooled to about 11° Abs. by means of solid Hydrogen and then is thermally isolated from the surroundings; the helium is now allowed to escape through the inlet itself. The work done in the expansion cools the helium so that about 60% of it becomes a liquid and remains in the vessel. The method is so simple that it could be easily demonstrated before the meeting. In the discussion that followed it was suggested that by demagnetising gadolinium sulphate, even 0·1° Abs. might be reached whereas the lowest temperature reached by evaporating helium was 0·7° Abs. (Keesom, 1932). Further details of the method are to be published in the *Zeitschrift für Physik.*

Production and Hatchability of Eggs as affected by different kinds and quantities of Proteins in the Diet of Laying Hens.

[By T. C. Byerly, H. W. Titus and N. R. Ellis. *J. Agric. Res.*, **46**, 1933. 1.]

THE above has been the subject of a number of previous researches, but the present authors would appear to be the first to obtain quantitative data in support of their conclusions. The results bring into relief the following—(1) feeding with meat, fish, crab or butter-milk as the source of protein led to not only more intensive egg production but also better hatching than that with grains and vegetables; (2) increasing the percentage of protein in the diet within limits of 11·2 and 23·6 augmented egg-production by increasing (*a*) intensity of production, (*b*) average egg-weight, and (3) diets containing vegetable proteins only increase the incidence of chondrodystrophy in the embryos of hens. Embryos in eggs from such hens had also a high second-week mortality.

The above results would suggest that there was some fundamental deficiency in the vegetable proteins tried by the authors. It would be of interest to extend their observations to different other forms of vegetable and animal proteins and to determine the precise chemical nature of the deficiency leading to chondrodystrophy in chicken.

Habits, Structure and Development of *Spadella cephaloptera.*

IN this excellent paper Mr. C. C. John (*Q.J.M.S.*, Vol. **75**, Part 4, 1933) has endeavoured to bring together a great deal of information relating to the structure and development of *Spadella cephaloptera*, a Chætognath. The work is all the more welcome in the field of zoology as no previous description of either development or habits has been satisfactory and as there are only a few scattered references to points of structure.

Several important points have been discovered with regard to the habits and structure. It is interesting to note that Spadella reproduces all the year round and that it can withstand reduced salinity and thus is pre-eminently adapted to life in bays and sounds in the mouths of rivers. The structure and function of the cement glands the secretions of which form a covering round the eggs are described for the first time. The corona ciliata which hitherto was supposed to be olfactory in function is experimentally proved to be a tactile organ. With regard to the nervous system it is noticed that the position of the vestibular ganglion and its nerves in Spadella is different from that in the allied genus Sagitta. There is a detailed account of the musculature and the chapter on reproduction is extremely interesting. The ovary is described as opening directly into the dorsal part of the seminal receptacle whereas in Sagitta there is a double duct along the outer side of each ovary opening posteriorly at the level of the rectum into the seminal receptacle. There is in Spadella a distinct tube called vagina. In the chapter on development the general account of the sequence of early embryonic stages previously based on a study of whole mounts has been verified with sections. It is remarkable that though the egg contains yolk, cleavage is regular owing to its uniform distribution. The germ cells which originate before the formation of archenteric folds are observed to separate into the distinct ovary and testis by the formation of the secondary septum which is mesodermal in origin. The hood is shown to develop as a lateral fold

on each side and not by a splitting of the lateral ectoderm as recorded by Doncaster in his paper on Sagitta. The male duct in Spadella is formed partly from the ectoderm and partly from the endoderm. In conclusion, it can be said that the paper constitutes an excellent monograph which is sure to become classical as it fills a gap in our present knowledge of the phylum Chætognatha.

The Element of Atomic Number 61.

[Maurice Curie and S. Takvorian. *Comptes Rendus*, **196**, 923, 1933.]

THE discovery of the radioactivity of Samarium has been recently announced by Hevesy and Pahl (*Nature*, **130**, 846, 1932) who suggest that this activity may be due to the presence of the element of atomic number 61. Libby and Latimer have confirmed the fact that Sm is radioactive and they also suggest that Nd and La are also possibly radioactive.

The authors measured the activity of different fractions obtained when a mixture of oxides of Nd (atomic number 60) and Sm (62) containing some La and Pr and obtained from Indian Monazite was being separated by fractionation according to the method of G. Urbain. They used a very sensitive Wulf electrometer to measure the activity and found that within the limits of sensitiveness of their apparatus Nd and La do not show any radioactivity. Sm was shown to emit a very easily absorbed radiation which could not be attributed to element No. 61. There was, however, a more penetrating radiation which showed a maximum of intensity in that sample in which element No. 61 was expected to be most abundant. The penetrating power of this radiation was too large for it to be a stream of α-particles. These interesting researches are being continued.

Effect of Dairy Manufacturing Processes on the Nutritive Value of Milk—The Apparent Digestibility of Fresh Whole Milk and of Powdered Whole Milk.

(*Journ. of Nutrition*, **6**, 139, 1933.)

FEEDING experiments with albino rats have shown that the apparent digestibilities of total protein, fat, sugar and total solids present in fresh whole milk and powdered whole milk as prepared by the spray or roller process are very nearly the same. There is no experimental evidence to suggest that any one type of preparation is more completely digestible than the others. There is an indication, however, that there is variation between individuals with respect to their tolerance for certain preparations so that sometimes fictitious impressions with regard to relative total nutritive values are obtained.

The above observations are of much interest though further experiments with human subjects will be needed before any definite conclusions can be drawn. Investigations of this type have already been carried out elsewhere with school children and it will be of much practical importance if further researches can be organized with the co-operation of a number of residential institutions and under the guidance of a competent body of doctors and statisticians.

The Most Probable Values of e and h.

[R. Ladenburg, *Ann. d. Physik*, **16**, 468, 1933.]

KIRCHNER (*Ann. d. Physik*, **13**, 59, 1932) assumed that the short wavelength limit of the Röntgen spectrum measured by a line grating was more accurate than that obtained by means of a crystal; using the value of $\frac{h}{e}$ so obtained and the value of $\frac{h}{e^{5/3}}$ deduced from the Rydberg constant and the value of $\frac{e}{m}$ obtained by himself, he calculated the values of e and h as follows:—

$$\frac{e}{mc} = (1 \cdot 7585 \pm 0 \cdot 0012) \times 10^{7}$$

(Kirchner's value).

$$R_{\infty} = 109737 \cdot 4. \quad c = 2 \cdot 9981 \times 10^{10}.$$

$$\text{Hence } \frac{h}{e^{5/3}} = (2 \cdot 2491 \pm 0 \cdot 0005) \times 10^{-11}$$

$\frac{h}{e}$ (Measurement of Duane and his co-workers)

$$= (1 \cdot 3787 \pm 0 \cdot 0008) \times 10^{-17}.$$

$\frac{h}{e}$ (Feder's value) $= (1 \cdot 3755 \pm 0 \cdot 0008) \times 10^{-17}$.

Hence $e = (4 \cdot 798 \pm 0 \cdot 006) \times 10^{-10}$,
$h = (6 \cdot 615 \pm 0 \cdot 012) \times 10^{-27}$
and $e = (4 \cdot 782 \pm 0 \cdot 006) \times 10^{-10}$,
$h = (6 \cdot 577 \pm 0 \cdot 012) \times 10^{-27}$.

Now Millikan's value of e is $4 \cdot 770 \pm 0 \cdot 005$. Accordingly, Ladenburg considers the above values of e as too high and calculates a more probable value as follows:—

From the photo-electric effect, according to Lukirsky and Prilez'aev,

$$\frac{h}{e} = (1 \cdot 3716 \pm 0 \cdot 0014) \times 10^{-17}.$$

From measurement of ionization potential of Hg by electron impact, according to Lawrence,

$$\frac{h}{e} = (1 \cdot 3752 \pm 0 \cdot 0027) \times 10^{-17}.$$

From the radiation constant c_2,

$$\frac{h}{e} = (1 \cdot 3728 \pm 0 \cdot 0030) \times 10^{-17}.$$

$$\text{Mean } \frac{h}{e} = (1 \cdot 3728 \pm 0 \cdot 0011) \times 10^{-17}.$$

These values show that the measurements with the line grating are unreliable.

$$\frac{e}{m} \text{ (Kirchner)} = (1 \cdot 7585 \pm 0 \cdot 0012) \times 10^7,$$

$$\frac{e}{m} \text{ (Houston)} = (1 \cdot 761 \pm 0 \cdot 001) \times 10^7,$$

$$\frac{e}{m} \text{ (Perry and Chaffee)} = (1 \cdot 761 \pm 0 \cdot 001) \times 10^7,$$

$$\frac{e}{m} \text{ (Campbell \& Houston)} = (1 \cdot 7579 \pm 0 \cdot 025) \times 10^7.$$

$$\text{Hence mean } \frac{e}{mc} = (1 \cdot 760 \pm 0 \cdot 0006) \times 10^7.$$

$$\text{Therefore } \frac{h}{e^{5/3}} = (2 \cdot 2486 \pm 0 \cdot 0003) \times 10^{-11}$$

which differs very little from Kirchner's value, $(2 \cdot 2494 \pm 0 \cdot 0005) \times 10^{-11}$.

Thus $e = (4 \cdot 770 \pm 0.006) \times 10^{-10}$.

Combining this with Millikan's value, *viz.*, $(4 \cdot 770 \pm 0 \cdot 005) \times 10^{-10}$ the most probable value of e is found to be

$$e = (4 \cdot 770 \pm 0 \cdot 004) \times 10^{-10}$$

and hence $h = (6 \cdot 547 \pm 0 \cdot 009) \times 10^{-27}$. Ladenburg concludes that the crystal measurements are correct while the line grating measurements are affected by some unknown error.

Using the above values, Ladenburg obtains

$$\frac{1}{a} = \frac{ch}{2\pi e^2} = 137 \cdot 307 \pm 0 \cdot 048.$$

This differs materially from Eddington's theoretical value $\frac{1}{a} = 137$.

Spermatogenesis of the Mouse.

PAUL R. CURTRIGHT of the University of Pittsburg has recently published a paper (*Journal of Morphology*, Vol. **54**, No. I, December 5, 1932) on the Spermatogenesis of the Mouse (*Mus musculus*, var. Albula) and confirms the diploid number of chromosomes to be forty. The number has been verified in the spermatogonia and the somatic cells of the mouse embryo. A continuous spireme is not present in the spermatogonia but elongate leptotene threads develop early in the prophase. There is no evidence of a 'bouquet' stage at any time. The sex chromosomes are of the X and Y type and are shown to exist early in the growth period. The X chromosome is a relatively short, three chromomered structure and the Y a shorter two chromomered one. The bivalents are of varied shapes and the union of the bivalents during diakinesis is very intimate. During diakinesis union takes place between corresponding chromomeres and this affords significant evidence of the allelomorphism of the chromomeres in the mammals. A chromosome nucleolus in the spermatocyte whose presence distinguishes the spermatogonial nucleus from that of the spermatocyte divides at the time of diakinesis and the divided portions which are equal in size are interpreted as the largest pair of autosomes. The haploid number of twenty is verified in both primary and secondary spermatocytes.

The Blood Circulation of Animals possessing Chlorocruorin.

H. MUNRO FOX (*P.R.S.*, **B 779**, Vol. 112) has described a series of very interesting experiments on the blood vascular system of Sabellids and Serpulids possessing chlorocruorin. The author, however, has not restricted himself to the polychætes but has also experimented on chick, crustacea and molluscan embryos with reference to reversible inhibition due to CO_2. He points out how the circulation of blood is rhythmic and is not under the control of the central nervous system. After the retreat of these worms into the tubes the pulsation in the vessel ceases. Spirigraphis is noted to live uninjured in such state for 8 hours after which it makes a fresh opening and comes out. Curiously, however, when these polychætes are placed in sea water whose pH is below 6·0, the contractions of the vessels stop. Possibly this cessation of pulsation is due to the accumulation of CO_2 in the tube when these animals contract.

Obituary.

Lt.-Col. A. W. Alcock, C.I.E., F.R.S.

1859-1933.

THE sad and sudden death of Colonel A. W. Alcock will be deplored by his large circle of friends and admirers throughout India.

Alcock was educated at Millhill, Blackheath, and Westminster, and after graduating as a zoologist served for about two years as an Assistant Professor of Zoology in the University of Aberdeen under Professor H. A. Nicholson, F.R.S. He passed the competitive examination for the Indian Medical Service and served as a medical officer with the Punjab Frontier Force from 1886-88. He was then selected for the post of the Surgeon-Naturalist to the Marine Survey of India in 1889. In 1892 he served for a short period as the Deputy Sanitary Commissioner, Bengal. On the retirement of Mr. J. Wood-Mason, Superintendent of the Indian Museum, in 1893, he was appointed to succeed him and served in this capacity till his retirement in 1907. He also acted as the Professor of Zoology in the Medical College, Calcutta, during his tenure as the Superintendent of the Indian Museum. In 1895 he accompanied the Pamir Boundary Commission as a Naturalist. After his retirement from India he worked as a Lecturer in Medical Entomology in the London School of Tropical Medicine, and in 1919 was appointed the Professor of Medical Zoology in the University of London. He retired from the latter post in 1924.

Col. Alcock was a very distinguished zoologist and from 1890 to 1907 he published nearly 50 papers on Marine Zoology of India. His systematic papers include accounts of Anthozoa, Echinodermata, Brachiopoda, Mollusca, Crustacea and Fishes. Amongst these contributions those on deep-sea fishes and crustacea deserve special mention. The series of papers entitled "Materials for a Carcinological Fauna of India" published in the *Journal of the Asiatic Society of Bengal* from 1895-1900 and in which he critically treated most of the marine families of Brachyurous Crustacea, are a rich mine of information and are indispensable to every worker in Carcinology, and particularly to workers on Indo-Pacific forms. His Catalogues of Decapod Crustacea and deep-sea fishes in the Indian Museum similarly contain very comprehensive accounts of the rich crustacean and fish faunas of the Indian seas. In 1910 Col. Alcock published a valuable memoir on the Potamonidæ, or the freshwater crabs of India. In addition, he published a number of papers on such diverse subjects as Viviparous Fishes, on an Instance of Natural Effect of Warning Colours, on the Toxic Properties of Saliva in certain Colubrine Snakes, on a New Flying Lizard from Assam, and on a New Apodous Amphibian from India. His masterly memoir on the Classification of the Culicidæ with particular reference to the Constitution of the Genus Anopheles published in 1911 laid the foundation of our present knowledge of the subject, and about the same time he performed an even greater service to tropical zoology by the publication of his very lucid text-book entitled "Entomology for Medical Officers".

Col. Alcock's work as the Superintendent of the Indian Museum also has to be specially considered. Alcock was almost the first zoologist to carry out original zoological research of a high order in the Indian Museum, Calcutta, and under very difficult conditions he carried out reforms of an outstanding nature in the general management of this institution, while his work in connection with the preparation and arrangement of the exhibits in the various public galleries of the Museum was particularly valuable. To popularise the Museum and make it possible for the lay public to understand the exhibits in the Indian Museum Col. Alcock wrote a series of very interesting and handy guide-books of the various galleries under his charge. Reference may also be made to the popular account of his work as a Naturalist on R.I.M.S.S. "Investigator", published in that delightful work entitled "Naturalist in Indian Seas" in 1902.

Col. Alcock's work on Marine Zoology of India earned for him the Honorary degree of LL.D. from the University of Aberdeen in 1904, while he was elected a Fellow of the Royal Society of London in 1901. He was awarded the Barclay Memorial Medal by the Asiatic Society of Bengal in 1907. He was a corresponding member of the Zoological Society of London, and of the Netherlands Zoological Society, and an Honorary Member

of the California Academy of Sciences, Philadelphia. He was elected an Honorary Fellow of the Asiatic Society of Bengal in 1911 and his services in the Indian Museum were recognized in 1903 by the grant of the title of C.I.E. B. P.

Science News.

Aneuploidy in the genus "Cassia".—MR. R. M. DATTA, Department of Botany, Presidency College, Calcutta, writes:—Aneuploidy unlike polyploidy, is not a very common phenomenon in the Angiospermous plants, and only in a very few genera, such as *Datura*, *Œnothera*, *Triticum*, *Vicia* and others, has this been recorded. It appears that as far as the leguminous plants are concerned, aneuploidy has been reported only in the genus *Vicia;* but this phenomenon is also seen in the genus *Cassia* of the same family. Saxton found n 12 chromosomes in *Cassia tomentosa;* Tischler recorded the same haploid number for *Cassia fistula*. Muto obtained n 13 chromosomes in *Cassia occidentalis* while Sethi reported n 14 in *Cassia didymobotrya*. The present writer records n 13 for *Cassia tora* and recently Ghose and Alagh record n 10 in *Cassia purpurea*. Thus so far as this genus has been cytologically studied the n chromosomes appear to be 10, 12, 13 and 14, the common numbers of haploid chromosomes for the family Leguminosæ being 6, 7, 8, 10, 11, 12, 13, 14, 16 and 24.

* * *

MR. P. M. GANGULI, Botanical Assistant, Assam Department of Agriculture, describes a method of crossing work in rice (*O. sativa*) in which he states nearly 90% success has been obtained. The process described by him is the same as that adopted by Sarangapani (1924) in the *Agricultural Journal of India*, with this difference, that instead of tying the glumes with fine silk, he has used rubber rings cut out of cycle valve tube to close the glumes which generally tend to remain open after emasculation.

* * *

Sixteenth Session of the International Geological Congress:—The third circular for the sixteenth session of the International Geological Congress, which is to meet in Washington, U.S.A., from July 22 to 29, has been issued. It contains full information about meetings and about excursions, with costs. Before the Congress there are excursions to various parts of the Eastern United States, lasting from 4 to 12 days, and a transcontinental excursion eastward from San Francisco for those coming to the Congress from the West. For those arriving at New York too late to take part in these longer excursions there will be a number of short trips to nearby areas of geologic interest. Alternate days during the sessions of the Congress will be given to excursions to areas around Washington. After the sessions, there will be two longer transcontinental excursions, each lasting 31 days, and two shorter excursions, one for the study of the glacial geology of the Central States, the other for the study of the pre-Cambrian area, including the iron and copper deposits, of the Lake Superior region. In order to make these excursions generally available, it has been possible, through the generous assistance of the Geological Society of America, to offer the longer excursions at a considerable reduction below actual cost.

For special discussion at the scientific sessions in Washington the following topics are announced:

- Measurement of geologic time by any method.
- Batholiths and related intrusives.
- Zonal relations of metalliferous deposits.
- Major divisions of the Palæozoic era.
- Geomorphogenic processes in arid regions and their resulting forms and products.
- Fossil man and contemporary faunas.
- Orogenesis.
- Geology of petroleum.
- Copper resources of the world.

Membership in the Congress is open to anyone interested. A copy of the third circular and other information can be had from W. C. Mendenhall, General Secretary, U. S. Geological Survey, Washington, D.C.

* * *

At the Ordinary Monthly Meeting of the Asiatic Society of Bengal, held on Monday, the 1st May, 1933, Dr. S. L. Hora read a paper on Mud-fishing in Lower Bengal.†

With the change of seasons in India, the methods of fishing also change. During the rainy season, when the country is flooded, the waters run high in rivers and streams and stand deep in pools and ponds. At this time of the year the fish are rather difficult to catch, and cast-nets and other types of nets are used to collect them. With the beginning of the dry season, the waters begin to fall and the fishes are restricted more and more to shallow, confined waters, where they are liable to be easily netted or even caught by hand. The term mud-fishing is used in connection with several ingenious devices for catching fish in the dry season by hand in almost semi-liquid mud. In his paper the author has described four such methods of fishing and the kinds of fish and crustacea obtained by these methods are enumerated.

The biological significance of this study is that it reveals the great adaptability of several of our commoner species to highly adverse conditions of existence. There are two important ecological factors which an animal association living in pools and puddles in Lower Bengal has to contend with, namely, the variation in the salinity of water due to floods and evaporation: and secondly the rapidly decreasing quantity and final disappearance of water during the dry season, and the consequent lack of facilities for aquatic respiration. The present paper deals only with the methods of fishing, while biological notes on the catch are reserved for a subsequent communication.

Mr. M. S. Mani then showed an exhibit of a Gall-section showing Cyst Formation and spoke thus:—

" While investigating the response of the vegetable tissues to the stimulus from the gall-makers, it was observed that the stimulus was simultaneously of a mechanical, physical, and chemical nature. The response of the plant was found to be a kind of resistance to the changes brought

†The following is from the Society's Proceedings.

about by the enzymatic secretions of the gall-maker. Thus it is known that in oak galls the plant produces tannin. The gall-makers produce diastase and invertase, which destroy plant cells. These substances are themselves precipitated by tannin and rendered powerless. The gall-maker produces, in addition, tannase and other oxidizing enzymes. Tannase hydrolyses tannin to gallic acid, so that the two cell-dissolving enzymes, diastase and invertase, are not precipitated. The gallic acid changes to pyrogallol which is oxidized by the oxidising enzymes to purpurogallin, so that at every phase the plant responds to various changes, though at last overcome by the gall-maker. In some cases of attack of parasitic fungus, the cells are rapidly suberized just in front of the fungal hyphæ, so as to place a kind of barrier in the way of the attacking foe. A somewhat similar adaptation to changing conditions was noted in certain entomocecidia also. The enzymes secreted by the Itonid larva were found to give rise to suberization of cell walls. The cells surrounding the tunnel occupied by the Itonid become thickly suberized and thick-walled. In the slide exhibited here, a transverse section is mounted of the solid-stem gall of *Pongamia glabra* Vent. Embedded in the parenchyma may be seen a large circular hole, the larval tunnel. This is surrounded by several concentric layers of thick-walled cells, the suberized ones. A hard fistular structure made up of these thick-walled cells encloses the Itonid larva. The larva appears as if it were encysted in the flesh of the gall and on this account the name cyst has been given to the tubular structure. The cyst appears to act as a kind of barrier to the irritant activity of the Itonid, so that after suberization and cyst-formation, active cell-proliferation is nearly brought to a standstill and the gall practically ceases to grow. This curious phenomenon will be further explained."

* * *

The Registrar, University of Madras, Triplicane P.O., Madras, writes :—

"The Ramanujam Memorial Prize," of the value of Rs. 500, will be awarded for the best essay or thesis written on any branch of Mathematics, embodying the result of the personal investigations of the author and containing clear evidence of independent and original research. The prize is open to all persons born or domiciled in India. Intending competitors should forward the manuscripts so as to reach the Registrar *not later than the* 1*st December* 1933."

* * *

At the 12th Annual Meeting of the Indian Botanical Society held at the Science College, Patna, on the 3rd January with Dr. S. L. Ghose in the Chair, Dr. D. H. Scott, F.R.S., and Prof. F. O. Bower, F.R.S., were unanimously elected Honorary Members of the Society. The following were elected Office-Bearers for this year: *President:*— Prof. S. P. Agharkar. *Vice-Presidents:*—(1) Dr. T. Ekambaram, (2) Prof. J. H. Mitter. *Secretary:*— Dr. S. K. Mukerji. *Treasurer & Business Manager:*—Prof. M. O. P. Iyengar. *Counsellors:*— (1) Prof. S. R. Kashyap, (2) Prof. B. Sahni, (3) Prof. S. R. Bose, (4) Prof. P. Parija, (5) Dr. Janaki Ammal, (6) Prof. S. L. Ajrekar, (7) Prof. K. C. Mehta, (8) Dr. P. C. Sarbadhikari, (9) Prof. M. A. Sampathkumaran, (10) Dr. K. Bagchi. *Members of the Editorial Board:*—(1) Prof. B. Sahni, (2) Dr. H. Choudhury.

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"NEW SCIENTIFIC INSTRUMENTS" by Messrs. Adam Hilger, Ltd., 98, King's Road, Camden Road, London, N. W. 1. (1) *Increasing the quantitative accuracy of a spectrometer.* In the pamphlet of the above title a simple eyepiece attachment, the Insta Eyepiece for a spectroscope is described. It is so designed that a spectrum line of a minor element present in a substance can be accurately compared in intensity with a neighbouring line of a principal element in the substance. The relative intensities of the lines bear a relationship to the proportions of the elements giving rise to them and when once this relationship has been established for a given substance (a fairly simple matter), quantitative analyses of samples of that substance can be carried out with great rapidity. The most useful application of this eyepiece is in the determination of exceedingly small proportions of elements. The Spekker Steeloscope is rendered still more useful by the addition of such an accessory and is listed complete with the Insta Eyepiece. (2) *The Campbell Solution Calculator.* This four-page booklet describes a novel apparatus for use in a method of calculating the behaviour of solutions described by E. A. Guggenheim and W Hastings Campbell (*J. Soc. Chem. Ind.*, **51,** 161T. 1932). This new graphical treatment is said to have the advantage over the classical treatment that it gives not only the compositions of the various phases involved but also the quantity of each phase involved in each operation. The apparatus should be of interest to all who are concerned with processes of purification by crystallisation and like problems in chemistry, whether in research or in large scale manufacture. (3) *The Notched Echelon Cell.* This booklet describes a new device which enables absorption spectra to be taken through 10 different thicknesses of solution *in one single exposure*, yielding on the plate a multiple spectrum consisting of those taken through the ten thicknesses of solution *each* together with an appropriate comparison spectrum. The last named is formed after the light has passed through a "control" (usually the solvent in which the substance investigated is dissolved) and through a resolving sector disc producing a known and uniform degree of absorption. Reading the plate consists in observing the wavelength (or wavelengths) at which the sector density equals density absorption due to the specimen for each thickness in turn. Means of simplifying the translation of plate reading into an absorption curve are provided. Among the advantages claimed for the apparatus are simplicity, rapidity and economy of solutions. A single exposure of one minute or even less suffices to yield all the data for an absorption curve. (4) *The Spekker ultra-violet spectrophotometer.* This four-page leaflet describes, with illustration, a new apparatus for absorption spectrophotometry consisting of a combination, on one base, of a Spekker Ultra-violet Photometer (described in *Trans. Opt. Soc.*, XXXIII, No. 1, 1931-32) and a Hilger Quartz Spectrograph (F_D 20 cm.) The spectrograph can be rotated away from the photometer for use alone in emission spectra and return to its position for spectrophotometry in an instant without readjustment. The instrument reads direct in wavelengths and densities.

Ern and Technocracy.—Under the joint auspices of three Scientific Societies that held a joint session during last Easter at Bangalore, Dr. G. J. Fowler delivered an address on the new system of currency that is engaging the attention of thoughtful men all over the world. After drawing attention to the present anomalous position of 'want in the midst of plenty' owing to the faulty system of currency prevalent at the moment, the lecturer proceeded to explain the significance of the terms, *Ern* and *Technocracy*. The *Ern* is an unchangeable unit, combining as it does, the unit of energy with the universal nitrogen. Technocracy may be defined as 'the control of social growth and progress under a system of economics based on energy out-put.' Experience of the past several centuries has shown that gold has never been a trustworthy standard. Money is not necessarily gold or silver, but is essentially an undertaking by Governments to pay the equivalent according to certain accepted standards. As conceived in the past, however, it has been an unreliable measure, chiefly owing to its having been based on units (gold or silver) which have themselves greatly fluctuated in value. Credit of some sort is always necessary for business transactions but the present system, particularly the elusive form known as the bankers' credit is fundamentally unsound. It spins 'like a top on a tiny apex of gold, deriving its momentum from the uncertain force of public confidence and its extent from the wisdom or whim of the banker.' Energy representing, as it does, the capacity for doing work either in man or in nature is inexhaustible: it is interchangeable from one form to another: it is always measurable and unwavering in its value. Mechanical energy does not, however, satisfy all human needs. Food is the source of biotic energy which is necessary for the human machine to direct the forces of nature. It is made up of a number of constituents like carbohydrates, fats and proteins, but the one that is consumed most uniformly by man—irrespective of race, creed or climate—is nitrogen which has to be considered in any rational system of currency. The *Ern* combining, as it does, the forces of the factory with those of the farm thus constitutes the unit of real wealth in this world. It cannot be cornered at any time because both nitrogen and energy are inexhaustible. In the eyes of the scientific economist the present world is "very sick". The machine has mastered production, but has not achieved distribution and consumption: it has multiplied the nation but has not increased the joy. In the new world to come the will to serve must replace the will to power.

* * *

The Burrowing Habits of Pseudo apocryptes lanceolatus Bloch and Schn. At a recent meeting of the Asiatic Society of Bengal Dr. S. L. Hora exhibited specimens of this estuarine air-breathing Gobiid together with portions of a burrow which the fish make during the hot weather. He remarked on the general habits of this species of marine fish which æstivate during summer and on their general physiological condition when exhumed from their underground retiring places. While in this state, the fish depend upon the atmospheric air for supporting their respiration and the water, such quantity as may be present in the burrows, being too turbid and foul for this purpose. The utilization of air for respiratory purposes by the dipnoan fishes is well known an the observations on similar habits among th members of this species of marine fish have bee made for the first time, though such habits ar common among the fresh water fishes possessin an accessory air-breathing apparatus. Ophio cephalus and Saccobranchus which live in tank drying up during the hot weather have bee noticed to retire into the crevices of the soft claye soil and remain in a state of torpor till the rain arrive. They have been taken out from a dept of two to three feet sometimes from the surfac of the ground and during this period of enforce rest, their metabolic functions are at a minimum though the gonads are in a state of intense activity Contrary to expectations, the deposit of fa in the organs like liver, the heart and in th neighbourhood of the gonads, during this period o quiescence takes place far more rapidly and i a greater measure than during the active conditio of the fish. The langour which overtakes the while in this condition is due to the low rat of their metabolism and if the hot weather is pro longed, most of the fish, especially the immatur ones in which the air-breathing organs are no fully established perish. Specimens of these fres water fish have been frequently taken from th burrows of crabs which make holes near th margins of tanks, which are flooded during th rains, thus facilitating the escape of the fish int their natural element. Dr. Hora's observation are extremely interesting and the burrowin propensities of this estuarine fish are an adaptiv modification to the conditions of the habita which they affect, an investigation into the ana tomical relations of the circulatory and respira tory organs and into the physiological activit of the genital organs before and during æstivatio may add certain fresh facts of far-reachin importance to our knowledge of the air-breathin examples of fishes.

* * *

We acknowledge with thanks the receipt of th following:—

"Journal of Agricultural Research," Vol. 4(Nos. 1 to 3.

"Nature," Vol. 131, Nos. 3306 to 3311.

"Chemical Age," Vol. 28, Nos. 715 to 719.

"Medico-Surgical Suggestions," Vol. 2, Nos. to 4.

"Natural History," Vol. 32, Nos. 1 to 6 an Vol. 33, Nos. 1 and 2.

15th Annual Report of the National Researc Council of the Dominion of Canada, Ottawa.

"Scientific Indian," Vol. 9, No. 51, March 193

"Canadian Journal of Research," Vol. 8, No.

"The Indian Forester," Vol. 59, No. 4, Apr 1933.

U. S. Department of Commerce Bureau of Sta dards Research papers:—

471 "A New Determination of the Atom Weight of Osmium" by Raleigh Gilchrist. 48 "The Synthesis, Purification, and certain physic constants of the Normal hydrocarbons fro Pentane to Dodecane, of *n*-Amyl Bromide and *n*-Nonyl Bromide" by B. J. Mair. 487 "A Cal rimetric Method for determining the Intrins Energy of a gas as a function of the Pressure" b Edward W. Washburn. 488 "The Photograph Emulsion: Variables in Sensitization by Dyes by B. H. Carroll and Donald Hubbard. 489 " method for the separation of Rhodium from Iridiu

and the Gravimetric Determination of these metals" by Raleigh Gilchrist.

"Brooklyn Botanic Record," Vol. 22, No. 2, 22nd Annual Report.

"Biochemical Journal," Vol. 27, No. 1.

"Journal of Chemical Physics," Vol. 1, Nos. 1-4.

"Arkiv fur Zoologie," Band 25, Hafte 1.

"Transactions of the Mining and Geological Institute of India," Vol. 28, Part 1.

"The Science Forum."

Report of the Meeting of the Supplemental Convocation of the University of Madras held on Monday, the 20th February 1933.

"Berichte Der Deutschen Chemischen Gesselschaft," 66, Jahrg, Nr. 4, April 1933.

"The Journal of Nutrition," Vol. 6, No. 2.

"Journal of the Urusvathi Himalayan Research Institute," Vol. 3, 1933.

State College of Washington, Agricultural Experimental Station, Pullman, Washington, Bulletin No. 276—"Observations and Experiments with Blueberries in Western Washington" by D. J. Crowley.

"Bulletin of the U.P. Academy of Sciences," Vol. 2, No. 3—

"On some Experiments with iodine vapour" by G. R. Toshniwal; "On the Determination of the Vapour Pressures of Zinc Bromide" by M. S. Desai; "On the Absorption Spectra of Alkyl halides" by P. K. Sen Gupta; "An X-Ray Investigation of the Crystals of Diphenyl Nitrosoamine" by Mata Prasad and S. G. Khubchandani; "Viscosity of Ferric Phosphate sol at various Pressures" by S. Ghosh and S. N. Banerji; "Influence of Temperature and light intensity on photosynthesis and respiration and an explanation on 'Solarization' and 'Compensation Point'" by N. R. Dhar; "Chemical Examination of the fruits of *Tribulus terrestris* Linn." by Narendra Nath Ghatak; "Peroxydase from the fruits of *Tribulus terrestris*" by N. Ghatak and K. Venkata Giri; "Studies on the Effect of Phosphates on Respiration of green leaves: 1. Eugenia Jambolana, 2. Allium Tuberosum" by U. N. Chatterji; "On an Echinstome cercaria-cercaria palustris—with notes on its Life-History" by R. C. Chatterji.

Reviews.

EARLY BELIEFS AND THEIR SOCIAL INFLUENCE. By Edward Westermarck, Ph.D., Hon. LL.D. (Glasgow and Aberdeen). Macmillan & Co., Ltd. 7/6 net. 182 pp.

In this interesting little book, Dr. Westermarck has treated the influence of early religious and magical beliefs and practices on our social relationships and institutions. He tells us that this discourse was for the most part delivered in the form of lectures at the London School of Economics and Political Science, during the Spring of 1931, and that it is based on his books, *The Origin and Development of the Moral Ideas, The History of Human Marriage, Ritual and Beliefs in Morocco*, etc., etc.

The book is divided into ten chapters. In a work covering only 172 pages, it is impossible to expect anything like an exhaustive treatment of the subjects dealt with. But those aspects which Dr. Westermarck has selected, he has treated fairly fully and all his conclusions are supported by a plentiful array of illustrations.

The first chapter deals with Religion and Magic, the precise meaning to be attached to these terms, the features that connect and distinguish them. Religion is defined as a belief in and a regardful attitude towards a supernatural being, on whom man feels himself dependent, and to whose will he makes an appeal in his worship. "In magic man attempts to influence either natural or supernatural objects or persons by supernatural means which act mechanically." No one will be inclined to question the adequacy of these definitions, especially as Dr. Westermarck himself points out that sociologists may more profitably occupy their time than by continuous quarrelling about the meaning of terms.

In the second chapter Dr. Westermarck considers the political and moral influence of Early Religion. He observes, quite rightly, that "the importance of the religious bond, and, especially, in tribes that have totemism, the totem bond, has been exaggerated by many anthropologists." Religion sometimes does influence nationality, but more frequently it is nationality that influences religion, especially among the more developed races. Islam is a democratic religion, but it has not succeeded in coalescing the Arab, the Turk, the Persian, the Syrian and the Egyptian into one nation or State. Mutual rivalries and jealousies keep them apart notwithstanding their having a common religion. In British India we are witnessing the growth of a nation whose component parts owe allegiance to a variety of religious faiths. Dr. Westermarck considers that the moral influence also of religion has often been greatly exaggerated. He states, "It seems to me to be a fact beyond dispute that the moral consciousness has originated in emotions entirely different from that feeling of uncanniness and mystery which first led to the belief in supernatural beings." One cannot be so sure that religion and morality had entirely different origins. Even if it

were so, even if religion was not the parent of morality, it is obvious that you cannot have a system of morality without a strong background of religious belief. The two have, throughout recorded history, shaped and fashioned each other.

Regarding private property with which the third chapter deals, Dr. Westermarck observes that religious sanction given to ownership is undoubtedly connected with curses pronounced by men, cursing being a frequent method of punishing criminals who cannot be reached in any other way. In the same chapter Charity is also dealt with. After pointing out the high place charity is given in all religious systems, Dr. Westermarck tries to trace the connection between charity and religion. He states that the curses and blessings of the poor partly account for the fact that charity has come to be regarded as a religious duty, containing, as they generally do, the invocation of a god. Besides the belief in the efficacy of curses and blessings, there is the connection between alms-giving and sacrifice.

A belief in the efficacy of curses and blessings, according to Dr. Westermarck, is the foundation of many of our social institutions. He traces hospitality and the right of sanctuary which are so necessary in a wild country to these sources. Regarding hospitality he says in the fourth chapter, if efficacy is ascribed to the blessings of even an ordinary man, the blessings of a stranger are naturally supposed to be still more powerful, for the unknown stranger, like everything unknown and everything strange, arouses a feeling of mysterious awe in superstitious minds. If hospitality owes its origin to the expectation of a blessing from the guest, the right of sanctuary owes its origin to the fear of the curse of the refugee. "It is not only men who have to fear the curses of dissatisfied refugees; gods are also susceptible to curses hurled at them." To the same source, *viz.*, the belief in the efficacy of curses and blessings are traced the subjection of children, and trial by ordeal. A belief in the mystic efficacy of the spoken word is said to be at least partly responsible for the virtues of truth and good faith. These and the notions of justice and criminal law are all fully dealt with in Chapters V and VI. The remaining chapters deal with "Duties to Gods", "Marriage and Sexual Relations", "Marriage Rites" and "The Position of Woman". As a general remark few will be disposed to quarrel with Dr. Westermarck's observation that men attribute to their gods a variety of human qualities, and their conduct towards them is in many respects determined by considerations similar to those which regulate their conduct towards their fellowmen. But exception must be taken to his statement "The Vedic gods wore clothes, suffered from constant hunger, and were great drunkards." A sweeping statement of this kind will leave an altogether wrong impression on the mind of the reader.

Dr. Westermarck explains why an atheist is regarded with horror. He says "one of the greatest insults which can be offered a god is to deny his existence" and the reason is "that a person is always most sensitive on his weak points and that the weakest point in a god is his existence." This is only a half truth. Every kind of non-conformist challenges and disturbs our cherished beliefs and hopes. He affronts our understanding and weakens our self complacency. The atheist and the rebel are penalised more as disturbers of public peace than as offenders against divine or mundane majesty. Dr. Westermarck himself notes in another place, that in early religion it is of the greatest importance that the established cult should be observed.

The last two chapters furnish very interesting reading. Many of our marriage rites which are observed to-day without meaning or significance are tracked to their humble sources. The bulk of these rites are shown to have originated in magical ideas. Thus the custom of throwing grain or dried fruit at weddings has generally been regarded as a means of securing offspring, in accordance with the principle of sympathetic magic, grain and fruit being sources of fertility. Guns (or fire-works) are fired off at weddings to dispel evil spirits or other evil influences. Old shoes are thrown at the bridal pair in many countries in Europe. Dr. Westermarck thinks that this was meant to serve as an extra magical protection to the parties. The position of inferiority which woman has occupied in all societies and under all religious systems is ascribed to her physiological uncleanness. But it is said to have had its compensations. "The notion that woman is an unclean being charged with mysterious energy has not only been a cause of her degradation, it has also given her a secret power over her husband, and even been a source of rights and privileges."

Woman's physical weakness was at least as potent a factor as her uncleanness in reducing her to subjection. Weakness at all times has been an open invitation to the practice of cruelty and tyranny.

This rapid sketch of the contents of this admirable little book, hardly does justice to the wealth of material gathered in it, or to the close reasoning on which the conclusions are based. Dr. Westermarck's works have already become classics. Students of Sociology look for nothing but first class work from his pen, and they will not be disappointed in his *Early Beliefs and their Social Influence*.

* * *

STATISTICS IN THEORY AND PRACTICE. By L. R. Connor, M.Sc. (Sir Isaac Pitman & Sons, Ltd. 1932. 12/6.)

This is an elementary text-book suitable for students of Economics and Sociology, and is one exceedingly good at that. Simple Algebra up to the Binomial Theorem is all that is assumed on the part of the student, and accordingly the book deals up to, and with, elementary problems in sampling. There is also a chapter on the simpler problems of Finite Differences and Graduation. The more important part of this book, however, is that devoted to "Applied Statistics". In twelve chapters the whole range of economic statistics is covered and special attention should be invited to the very clear and useful chapter on Business Barometers and Business Activity Indices. It is claimed in the Preface to this book that this is an age of Statistics, to which may well be added that it is an age also of books on Statistics. This one, however, does credit both to the author and the publishers.

K. B. MADHAVA.

* * *

THERMIONIC VACUUM TUBES AND THEIR APPLICATIONS. By E. V. Appleton, M.A., D.Sc., F.R.S., Pp. 117 with 68 diagrams. (Methuen & Co., Ltd., 3*sh*. net.)

Since the publication in 1920 of Van der Bijl's excellent treatise nothing comparable to it in scope and character has been published, at any rate in the English language, consistent with the sustained and remarkable progress in the development and application of thermionic tubes.

In this small monograph, Prof. Appleton has in view the needs of the student of physics and the radio amateur desiring to obtain a proper understanding of the internal physical action of thermionic tubes and their behaviour in typical circuits. A short reference to the laws of the thermionic emission of electricity is followed by a brief description of the construction of modern receiving tubes. The influence of the geometrical disposition of the electrodes on the performance of the diode and triode are examined in a few typical cases. The chapters on the triode as amplifier, rectifier and oscillator of oscillations cover the usual ground and are models of clear exposition of the essentials. The author has touched upon such subjects as the generation of extremely short waves, soft tubes, the multi-vibrator, etc.

Even in the small space of this monograph, some mention was expected regarding transmitting tubes, their construction and their behaviour in typical cases. The author has completely omitted this aspect of the subject. Some space might have been devoted also to the advantages, in certain cases, of the use of the anode-voltage-anode current characteristics of a triode. There are a few other omissions but of a minor character.

Despite these, the book gives a very lucid and concise account of the physical action of a scientific appliance of increasing service and popularity. The list of references at the end of each chapter enhances the value of the book to the reader.

R. E.

* * *

AN INTRODUCTION TO SCIENCE, BOOK II—SCIENCE AND LIFE. By E. N. Da C. Andrade and Julian Huxley. Pages 248 (Basil Blackwell, Oxford.)

The recent introduction of the biological sciences in the syllabus of the secondary schools is a step in the right direction. Formerly, attention was concentrated on the study of the physical sciences and biology was sadly neglected. But the mere introduction of biology is not all. Even to-day the three branches of study are treated in water-tight compartments and each is studied independently of the others. This procedure is not fruitful of desirable educational results, inasmuch as it circumscribes the mental horizon of the secondary school boy. Nowadays the border lines between the branches of science are fast vanishing and this is very helpful in widening the outlook of the mind, which is the essence of scientific education. Hence the imminent necessity for a syllabus that is a harmonious blend of the three main branches of scientific knowledge.

The book under review is one intended for the boy entering the secondary school. Here the classic syllabus is treated in a novel way. The main subject dealt with is undoubtedly biology, while physics and chemistry appear as its hand-maidens. The treatment of biology or the physical sciences, in sections all by themselves is entirely dispensed with. The three subjects are treated in their inter-relationship. In the preface the authors say that this is the second of a series of four books intended to cover the whole field of elementary science. So this book is a direct outcome of Book I. As regards the treatment of the subject itself, though it lacks the rigours and austerities of the usual text-books, it arouses interest without encumbering the mind with many technical details. Throughout the book the fundamental idea of the oneness of nature is never lost sight of, and as far as possible the inter-dependence of living creatures is stressed upon. Science is here made an organized and living body of knowledge and not a class-room subject. The mysteries of the laboratory are to a great extent unravelled and treated in a manner easily understood by the beginners. The authors themselves, who are eminently qualified to the task before them, have spared no pains to make themselves explicit. Technical jargon finds no place here while the intricate workings of nature are presented in a language which is alike popular and chaste. The experiments mentioned are all amply illustrated by figures, which, while preserving a sense of proportion, are highly explanatory. The book itself is very handy and the general get-up attractive.

Without any hesitation, we would strongly recommend this book to the secondary school boys, who might be said to be at the threshold of science. The adoption of this series will, we hope, introduce a new outlook in the teaching of science in the secondary schools which is very badly needed.

C. N. R.

Two Statements.

The Alimentary Glands of the Earthworm *Eutyphœus*.

I AM sorry for the following incorrect statements made by me in my note published in the February, 1933, number of *Current Science*, which, I have now been satisfied, are not justified by the actual facts of the case:—

(1) "The work on the Physiology of the glands, now claimed by Dr. K. N. Bahl as his own was actually carried out as late as 1929 by one of our former students, now colleague in the Department."

(2) "I would certainly protest against his appropriation of the work of his colleagues and Assistants."

I withdraw these statements.

G. S. THAPAR.

I am very sorry for the words "In appropriating these results of mine" used by me in my note published in the February, 1933, number of *Current Science*, and I withdraw them.

Lucknow, K. N. BAHL.
April 23, 1933.

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CONTENTS.

The Road-Rail Conference.

THE recent discussions at Simla on the road-rail controversy have proceeded on the assumption that man is still rooted to the earth. Within the last quarter of a century he has succeeded in achieving a three-dimensional existence. The problems which confronted the Conference need not have been attended with the degree of acrimony which the lack of imagination in the bureaucratic mind about the trend of modern transport service has engendered. The whole discussion in the Conference bore an air of unreality, for in none of the speeches could one discover the realization of the fact that in a rapidly moving age of scientific discoveries and inventions no industrial or commercial concern, however strongly entrenched behind official support, can hope to enjoy protection indefinitely, unless it can visualise future developments and possess sufficient elasticity and power of adaptation.

The ostensible object of the Conference, as can be made out from the published speeches, is to discover the means of rendering the competition between the two systems of transport less wasteful, if not more profitable. This can be achieved only by making one of the services complemental or tributary to the other. A proposal of this character will naturally place the fields of operation by the road and rail system tangential and not parallel to each other. The consideration whether the bus service when restricted to the areas to be opened by the provincial schemes of road development, will continue to be a paying concern, has not fallen within the purview of the Conference. It is true that the security of railway service may be temporarily purchased by converting automobiles into subordinate feeders; and for this purpose the Government of India is prepared to raise a loan for launching an extensive scheme of road development in areas not served by railways. The mere construction of roads linking the isolated parts of the country with the more advanced distributing centres, does not offer hopes of promoting the social and economic prosperity of the rural population and when conditions of development such as irrigation projects, power service, organization of labour, modern scientific methods of cultivation and popularisation of subsidiary occupation are not simultaneously

introduced, the proposed costly roads are bound to remain ornamental failures.

According to Sir George Schuster, there are two favourable conditions at the present moment for raising a public loan in order to finance the provincial governments which are invited to adopt the doctrine that, "the main need on which the country should concentrate during the next phase of development is to develop the road system so as to bring that into balance with the railway system and provide a better circulation of traffic to railways." One of these conditions is that money is available at a cheap rate of interest rendering capital expenditure economically justifiable. The second condition is that the Government of India is not committed to any extensive capital expenditure and can therefore embark on the road development plan with cheaply available money. It is proposed to place the necessary funds at the disposal of the local governments, as soon as they produce schemes providing for the service of loans, the maintenance of roads and proofs of their economic productivity.

While we generally approve of the stipulations of the central government contrived to meet specific circumstances, we are not quite convinced of the economic expediency of incurring heavy public debts which add to the financial burden already none too light. Public credit like the giant's strength, is excellent to possess but grievous to use. One of the main objections to the loan policy of the government is that the exhaustion of public resources by offering attractive methods of investment, will result in a proportionate contraction of the capital for industrial development through private enterprise. It seems to us that for other and more serious reasons the present moment seems to be singularly inopportune for raising large sums of money from the public. With prevailing rates of low prices for the produce of the land, agriculture will remain for some time unhonoured. The sad spectacle of industrial collapse, such as is witnessed in Bombay, is sure to chill the ardour of the most enterprising capitalists for establishing new manufacturing concerns. To overstrain the public resources on the eve of momentous constitutional changes is a step likely to impose serious handicaps on the new Government. Above all, loans must necessarily produce serious repercussions on public revenues resulting in extensive curtailment of subsidies for consolidating and inaugurating schemes of moral and material advancement. But what is the solution for the acute competition of the dual transport systems in which the government and the country are equally involved?

We agree that the suggestion of the central government for an extensive scheme of road development may be expected to provide at least temporary relief; but we are not charmed with the methods proposed by them to secure the end. We hold that the situation could have been avoided through the exercise of a little imagination. In normal times, the public revenue and resources of special funds, such as we had advocated in these columns some time ago, should be adequate to handle an emergency of this character. However, Sir George Schuster points out that "the justification for the construction of roads from loans rather than from revenue must be that construction from revenue would be too slow to meet the needs of the case." A rapid completion of public works need not necessarily imply immediate improvement of their taxable capacity and especially in a case like the road development, in which, the loan is intended to be applied to a single limited purpose, the economic productivity of the proposals, depending as it does on the equally important collateral projects, must be a process of slow evolution. The alternative suggestion we make of utilizing the revenue and resources of reserve fund for developmental programmes offers advantages, such as consolidation, revision, periodical tests of the works and cautious application of the funds which should characterise the administration of public finance. The acuteness of competition has been permitted to grow over a fairly long period of time without thought of its pernicious character and the hasty remedy proposed to be applied is likely to shift the malady in a worse form to some other part of the social organism. Sir Guthrie Russell points out that the main cause of the present position is not motor competition,—it is the world-wide economic depression and the loss sustained by the railways on account of competition is estimated between one and a half and two crores of rupees, and for redressing this and for stimulating the economic productivity of the rural areas through road development, a loan amounting to three times this sum is proposed to be raised.

Sir Guthrie Russell's speech is devoted to the consideration of rendering the competition fair, by imposing statutory obligations on motor service, such as those under which the railways work. Some of them, especially those which ensure the safety and convenience of passenger traffic, are necessary in the interests of the public, but to enforce them all at once in the categorical order enumerated by the Chief Commissioner of Railways would kill the automobiles. But the position of the Government is that since the railways are capable of handling any volume of passenger and goods traffic, and of providing advantages, such as the road motor services cannot for a long time contemplate, it is only reasonable to withdraw automobiles from those roads of 1300 miles which run parallel to the permanent way. In an economic controversy of this nature, it is not the interests of the competing agencies alone that are involved, but those of the public which indeed are paramount. It seems to us that, should the Conference, instead of discussing the problems of competition and the prospects of public loans, have investigated the causes of the unpopularity and unattractiveness of the rail system of transport, a great step would have been taken in the solution of a controversy which is fundamentally psychological. Travelling and circulation of goods are the essence of civilized life and this fact should not be permitted to be exploited either by competition or combines or monopolies.

Perhaps, the Hon. Mr. E. Miller's plea for the early consideration of resolution No. 8 regarding a coordinating authority, envisaged the complexities of the situation in their proper perspective and their future relations. Within a very short time the Government and the people will be confronted with the problem of providing the country with a well-articulated system of water-rail-road-air ways working on a co-operative basis. If the railways are to be preserved from becoming obsolete, the problem of gauges should engage the attention of the authorities immediately. The transfer of passengers and goods from one gauge to another entails a certain condition of affairs which, if not remedied, must ultimately render the rail service totally unpopular. It is wasteful and uneconomic to protect defects in the means of transport which in a fair field of competition, will automatically be removed. Before the Government seek to impose statutory obligations on the bus service and stop the competition between road and rail systems of transport in places served by the railways, the public, especially that section which contributes 89 per cent of the railway earnings, should receive the fullest assurance that they will be provided with a cheap, sanitary and comfortable mode of travel in third class compartments.

We said that want of scientific imagination is the root cause of all our social and economic troubles and that resolution No. 8 on the agenda of the Conference is the most important one. We cannot forget the fact that for-shipment of goods and booking of passengers for less than forty miles, the bus and motor offer facilities which the railways can never hope to provide and it should be no wonder that in years to come an increasing volume of short-haul business is completely diverted to motor trucks. Besides the problem of distribution,—perhaps the most intricate problem with which the industries and transport service are confronted,—can approach a solution in the activities and success of the committee such as is contemplated in the 8th resolution.

During the last twenty-five years scientific discoveries and inventions have introduced us into a new world with a different outlook and environment. The evolution has been so rapid that readjustment has become difficult. The Government which lacks imagination to foresee the coming changes and to prepare for new adjustments will find itself in a vortex of trouble and deal with the altered conditions with crude and clumsy methods. If and when the Geneva Conference decides upon the abolition of aeroplanes for military service, the world will witness a new competition in commercial aviation which bids fair to render obsolete the existing systems of transport by land and sea. To meet this situation successfully Governments should begin to rely more and more on science to provide a suitable machinery for mutual adjustment among the competing services and if they do this, they would have laid the foundation of a lasting and orderly social structure.

Felicitations.

THE Birthday Honours list has brought the distinction of Knighthood to two of our editorial co-operators, Dr. M. O. Forster, F.R.S. and Col. R. McCarrison, C.I.E., whom we have pleasure in felicitating. It is highly gratifying to note that scientific service is suitably recognized by His Majesty's Government in India and we hope that other eminent scientific workers in the country will be speedily and fittingly honoured.

As administrator of the Indian Institute of Science which occupies the premier position in India, for the last ten years Sir M. O. Forster has rendered invaluable services in the expansion and consolidation of the research departments under his administrative care and his wide experience and knowledge, his eminent attainments and above all, his genial and stimulating perso nality have been a source of inspiration an liberal education to all who have com within the range of his influence.

Sir R. McCarrison is an intrepid researche in the science of animal nutrition,—wit special reference to goitre, and the results o his scientific labours have been internation ally recognized. He has been recentl elected to open the International Conferenc on Goitre at Berne and the Knighthoo conferred on him is a fitting recognition o his eminence as an investigator of th fundamental problems which affect huma welfare. We wish both of our co-operator who are the recipients of distinguishe honours, long life of increasing usefulness i the service of science and of the country.

On a Connection between Di- and Triatomic Molecules.

By Dr. H. Lessheim and Dr. R. Samuel,
Muslim University, Aligarh.

SINCE the recent development of the theory of molecular spectra it has become clear that it is necessary to pay consideration to the fact that chemical linkage does not always arise from the ground levels of the atoms concerned. We have therefore to add a certain amount of energy of excitation to the heat of dissociation of a compound in its atoms, if it is taken from thermo-chemical data.

The carbon atom, *e.g.*, in its ground level $s^2\,p^2\,{}^3P$ is able to form a linkage with one O atom only, since the complete group of two s-electrons is chemically inert and acts repulsively; a second O atom cannot be linked from the ground level. Therefore already other authors, *e.g.*, Mecke (*Zs. f. phys. Chem.* B. 7, 108, 1930) have tried to explain the linkage of CO_2 by assuming an excited C atom in the $s\,p^3\,{}^5S$ state. In a recent paper (*Zs. f. Phys*, in press) we could show that apparently an s-electron does not undergo a linkage with the p-electrons of a negative partner. So, for the second linkage of CO_2 we have to assume a C atom excited to the $p^4\,{}^3P$ state. This is all the more so because it is known from the chemical behaviour as well as from the infra red spectra that there is no difference between the linkages of the two O atoms.

In the case of the homologous molecul PbO we are in a position to prove this als from band spectrum data.

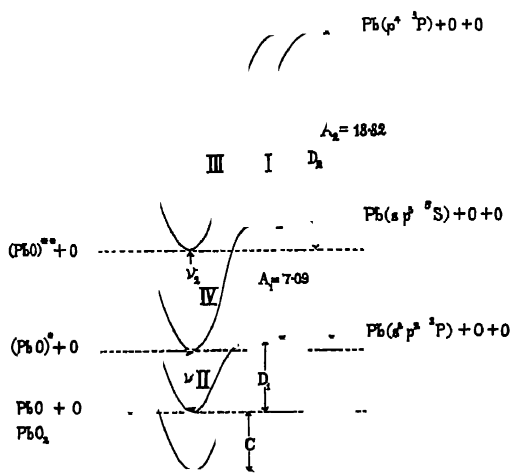
The thermochemical data are not full known, especially our knowledge of th specific heat and of the heat of evaporatio is insufficient. So the values of the mola heats of PbO and PbO_2 are graphicall extrapolated in the range where no measure ments are available, the values of the hea of evaporation are calculated by means c Trouton's Rule (Grüneisen's modification That the data employed in the calculatio are fairly correct can be taken from the fac that we found the heat of dissociation c PbO to be $D_1 = 4 \cdot 38$ volts, in best accor with the spectroscopical value $D_1 = 4 \cdot 2$ volts. Some uncertainty arises only in th case of the dissociation energy of PbO where we had to estimate even the meltin and boiling temperatures; but this does nc matter because we shall soon see how to ge rid of this uncertainty. We obtain prov sionally

$Pb_{at} + O_{at} = PbO_{mol} + D_1$ where $D_1 = 4 \cdot 3$ volts,

$PbO_{mol} + O_{at} = PbO_{2\,mol} + C$ where $C = 2 \cdot ($ volts,

$Pb_{at} + 2\,O_{at} = PbO_{2\,mol} + C + D_1$ where $C + I = 6 \cdot 43$ volts.

Considering the system Pb+O+O, we have found now three energy levels, the lowest one being that of PbO_2, another one of the system PbO+O, 2·05 volts higher, and a third one of the system of the separated atoms Pb+O+O, 6·43 volts above the lowest, each consisting of atoms and molecules in their respective ground states. The terms s p^3 ^5S and p^4 ^3P of Pb require an energy of excitation of A_1=7·09 and A_2=18·82 volts respectively. Thus we get



at curves I and II of the figure. Knowing as mentioned above that the amounts of energy by which the first and second O atoms are bound are equal, we have to halve the total dissociation energy of the PbO_2 bond (25·25 volts) to get the minimum point of curve III at ν_2=10·58 volts above the minimum point of II. This is the energy level of the system PbO+O, PbO being in that excited state in which it is able to accept the second O atom, and dissociating in Pb (p^4 ^{3}P)+O.

These calculations, if correct, enable us to predict the energy level of the PbO molecule derivable from the Pb in the s p^3 ^{5}S state. The amounts of energy wanted for the excitation of the first and second s-electrons though of course different in Pb and PbO will be in almost the same ratio in either case. We divide ν_2 in the proportion $A_1 : A_2$ and find the minimum point of the predicted curve IV at ν_1=3·99 volts above the ground level of the PbO molecule. The dissociation energy of the molecule in this state results to about 7·5 volts.

This method of calculation applies to any molecule of this kind. We selected PbO because the predicted energy level is well known from band spectra proving the soundness of the fundamental idea. The D-bands of PbO are a $^1\Sigma-{}^1\Sigma$ transition, the upper state lying at 3·71 volts with an energy of dissociation of 8·24 volts. Considering the uncertainty of the thermochemical data employed these figures are in full agreement with the predicted ones. Besides another electronic level (III) of the PbO molecule is predicted, arising from the Pb(p^4 ^{3}P) state with the electronic transition ν_2 from the ground level and the dissociation energy $D_2 = A_2 + D_1 - \nu_2 = \nu_2 + C$.

Putting the results in the form of equations we get,

$$\nu_1 = \frac{A_1}{2} + \frac{A_1}{2A_2}\,(D_1 - C) \qquad (1)$$

$$\nu_2 = \tfrac{1}{2}(A_2 + D_1 - C) \qquad (2)$$

$$D_2 = \tfrac{1}{2}(A_2 + D_1 + C) \qquad (3)$$

Now by means of equation (1) we can rid ourselves of the uncertainty in the thermochemical calculations and in the reverse find better values for the thermo-chemical data. Using the spectroscopical values ν_1=3·71 volts, D_1=4·27 volts, which are more exact, and introducing them into (1), we find,

$$PbO_{mol} + O_{at} = PbO_{2\,mol} + 3\cdot39 \text{ volts},$$
$$Pb_{at} + 2O_{at} = PbO_{2\,mol} + 7\cdot66 \text{ volts},$$

Total heat of dissociation of PbO_2=26·48 volts,

$$\nu_2 = 9\cdot85 \text{ volts},$$
$$D_2 = 13\cdot24 \text{ volts}.$$

As to the energy of the bonds of the different electronic groups another interesting result can be obtained. We have seen now that the upper state of the D-bands of PbO comes from the Pb(s p^3 ^{5}S) a result already got in another way in the paper mentioned above. The excitation of the molecule corresponding to the D-bands means the transition of an electron from $p\sigma$(s) in the lower state to $f\sigma$(p) in the higher one. Either group is a so-called promoted group, *i.e.*, it loses energy when the distance of the nuclei decreases. The energy of excitation $^5S-{}^3p$ of the Pb atom is higher than the corresponding energy $^1\Sigma-{}^1\Sigma$ of the PbO molecule. So the dissociation energy being higher in the upper level than in the groundmost one we can say that the promotion of the $f\sigma$(p) group cannot have started at the nuclear distance of the PbO molecule to any considerable extent or at least is much less

than that of the pσ(s) group, for otherwise the energy of dissociation would decrease with excitation.

Thus it is evident that there exists a near connection between the energy states of a diatomic molecule and a triatomic one derived from it. It is also shown tha atoms of the fourth family, *e.g.*, C, reall undergo a tetravalent linkage from th p^4 ^3P term. This has to be considered i many questions of thermo-chemistry. A ful report will be given elsewhere.

Influence of Wall Effect on the Nature of Coagulation Process.

By Dr. B. N. Desai, M.Sc., Ph.D.,
Wilson College, Bombay.

It has been realised by investigators in colloid chemistry that the walls of the containing vessel may affect the rate of coagulation. Desai (*Trans. Faraday Soc.*, **24**, 181, 1928; Patel and Desai, *ibid.*, **26**, **128**, 1930; Desai, *Kolloidchem. Beihefte*, **26**, 357, 1928; cf. Freundlich, Colloid and Capillary Chemistry—Eng. Translation—1926, p. 417) has discussed in detail the defects in the various methods used for following the course of coagulation which might be responsible for the observance or non-observance of the S-shaped coagulation velocity (C.V.) curves and the auto-catalytic nature of the coagulation process. In discussing the ultra-microscopic method it has been pointed out that the walls of the cell containing the colloid might have also some effect on the course of the coagulation reaction and that there is a possibility of greater percentage error with dilute sols—which alone can be used with this method—than with concentrated ones owing to the wall effect. In a concentrated sol the number of colloidal particles being comparatively larger than in a dilute sol, the effect of the walls in acting as centres for coalescence will be negligible.

In a recent paper S. S. Joshi and V. L. Narayan (Special Number of the *Journal of the Indian Chemical Society*, 1933, p. 41) have studied in detail the influence of wall area in the coagulation of colloidal solutions of MnO_2, Sb_2S_3 and (+ively charged) Fe_2O_3. The concentration of the disperse phase in the colloidal solutions tried by them is not very high. They have observed that the rate of coagulation is markedly increased in all cases when the wall area of the coagulating system is increased by introducing glass beads. They also find that when the same number of beads and the containing walls are paraffined, the coagulation is sensibly retarded in all cases. In the light of their results they consider unlikely that th increase in the rate of coagulation, unde wall effect alone, can convert a 'slow' int a 'rapid' coagulation. They conclud that auto-catalysis cannot be considered a a general characteristic of coagulation a has been supposed by some workers, bu that it is a secondary process which adds t the main course of coagulation under certai conditions.

It will not be out of place to consider i some detail the results of Joshi and Naraya in this letter as they have an importan bearing on the theory of slow coagulatio proposed by Freundlich (*loc. cit.*, pp. 431-447 As shown by electrosmotic, cataphoreti and stream-potentials measurements, th wall-layer of glass in contact with wate becomes negatively charged. The natur of this charge will be modified considerabl in the presence of electrolytes as well a when the glass surface is paraffined. It i therefore, certain that the glass surface wi help or retard the coagulation according t the nature of the charge on it and on th colloidal particles Moreover glass wal themselves, whether paraffined or not an whether charged or uncharged, will act a centres for coalescence. In view of thes considerations, it is not justifiable to sa that the results of Joshi and Naraya support the conclusion that the nature c coagulation process is not intrinsically auto catalytic.

On the other hand, their results can we be utilized to show that the nature c coagulation process is auto-catalytic. Fc as shown by them the walls of the contair ing vessel (unparaffined) make the S-shap of the C. V. curves less marked and it quite likely that non-observance of auto catalysis by some workers might be to certain extent due to this effect. As show by Desai (*loc. cit.*) the appearance of tl

S-shaped C. V. curves or demonstration of the auto-catalytic nature of the coagulation process depends on the concentration of the coagulator, the purity of the sol and the concentration of the disperse phase, apart from the suitability of the method employed.

Letters to the Editor.

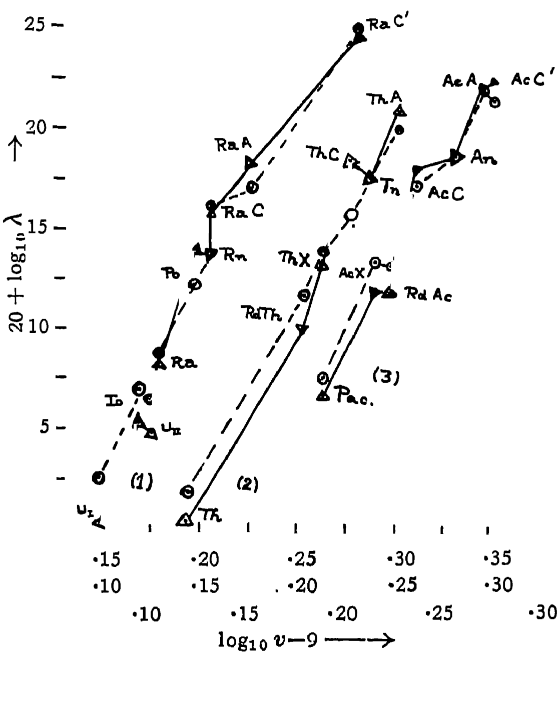
On the Radioactive α-Emission.

IN a recent paper (*Ind. Phys. Math. Jour.*, 1932) we have derived a wave-statistical expression for the damping coefficient of the phase space. In the above paper we assumed this coefficient to be identical with the disintegration constant for the α-particle. Later investigations of the authors, which are not yet published, show that the previous assumption is not justified. The disintegration constant is, however, related to the damping coefficient. It is shown that the constants are:

$$\lambda_{\text{damp.}} = -\frac{1}{N}\frac{dN}{dt} = \frac{\cdot 61}{h}\sqrt{U_o E} \quad [cf.\ \text{Eq. (36) L.C.}] \quad \ldots (1)$$

$$\lambda_{\text{dis.}} = -\frac{1}{N_a}\cdot\frac{dN_a}{dt} \quad \ldots \quad \ldots (2)$$

where N is the total number of α-particles inside the hard core and N_a the effective number present in a thin spherical shell just inside the core. It is evident that $\frac{dN}{dt} = \frac{dN_a}{dt}$.



Applying the solution to the shell and using the boundary condition one readily obtains [*vide* Eq. (24) L.C.]

$$\frac{N_a}{N} = \text{const.}\cot u_o\, e^{2k(2u_o - \sin 2u_o)}\, r_o^2 \Delta r_o \quad (3)$$

Combining (1), (2) and (3) we get

$$\lambda_{\text{dis.}} = \text{const.}\ \frac{\sqrt{E}}{r_o\, h \cot u_o}\ e^{-2k(2u_o - \sin 2u_o)} \quad (4)$$

The theoretical values of $\lambda_{\text{dis.}}$ calculated from the above equation closely agree with the standard experimental values for the three families of radioactive substances. This is evident from the graphs where the curves drawn continuous give the theoretical values.

K. C. KAR.
A. GANGULI.
Physical Research Laboratory,
Presidency College, Calcutta,
May, 1933.

On the Two Dimensional Statistics of Kar-Mazumdar.

IN a recent paper Kar and Mazumdar (*Zeit. f. Phy.*, **55**, pp. 546–554, 1929) have obtained the distribution functions of Bose-Einstein and Fermi by generalising Gibbs' statistics. In doing so, they have introduced, over and above the free energy ψ per molecule, a new class of free energy ψ_s per 's' type cell. Thus, according to them, the total free energy of all the cells is

$$\sum_s A_s \psi_s = \Psi_2 \quad \ldots \quad \ldots (1)$$

'A_s' being the total number of 's' type cells.

Now, as the extension of the old statistics is ultimately due to the structure of the phase space, Ψ_2 may be taken also as the additional free energy of N molecules arising out of the cells. Therefore, the total free energy is

$$\Psi = \Psi_1 + \Psi_2 \quad \ldots \quad \ldots (2)$$

where $\Psi_1 = N\psi$, the classical value of the total free energy.

According to the classical statistics,

$$-\frac{d\Psi_1}{dV} = P_{(mol)} = \frac{NKT}{V} \quad \ldots \quad \ldots (3)$$

Let us now evaluate $-\frac{d\Psi_2}{dV}$. According to Kar-Mazumdar

$$A_s\psi_s = \pm\, ln\left(1 \mp e^{\frac{\psi - u_s}{KT}}\right) \quad \ldots \quad \ldots (4)$$

From (2) and (4)

$$P_{(cell)} = -\frac{d\Psi_2}{dV}$$

$$= \mp \frac{KT}{V}\sum_s\left\{A_s\, ln\left(1 \mp e^{\frac{\psi - u_s}{KT}}\right)\right.$$

$$\left.\pm A'_s \Big/ \left(e^{\frac{-\psi + u_s}{KT}} \mp 1\right)\right\} \quad \ldots (5)$$

On substituting the usual value of A_s and on integrating the right hand side of (5) we get

$$P_{(cell)} = \frac{NKT}{V}\left\{\frac{F_{3/2}(\psi/KT)}{F_{1/2}(\psi/KT)} - 1\right\} \quad \ldots (6)$$

So the total pressure P is given by

$$P = P_{(mol)} + P_{(cell)} = \frac{NKT}{V}\frac{F_{3/2}(\psi/KT)}{F_{1/2}(\psi/KT)} \quad (7)$$

This is the well-known equation of state in the new statistics.

In the case of radiation $A_s = \frac{8\pi V \nu_s^2}{c^3}\, d\nu_s$, $u_s = h\nu_s$ and $\psi = 0$ so that $\Psi_1 = 0$, so we have as in equation (5)

$$P_{(Rad)} = -\frac{d\Psi_2}{dV}.$$

$$= -\frac{8\pi KT}{c^3}\left(\frac{KT}{h}\right)^3$$

$$\times \int_0^\infty ln\left(1 - e^{\frac{-h\nu_s}{KT}}\right)\left(\frac{h\nu_s}{KT}\right).d\left(\frac{h\nu_s}{KT}\right)$$

$$= \frac{8\pi KT}{c^3}\left(\frac{KT}{h}\right)^3 \times \frac{1}{3}\int_0^\infty \frac{x^3 dx}{e^x - 1}$$

$$= \tfrac{1}{3}\,\epsilon \text{ (Planck)}$$

Thus the above discussion strongly supports the idea of the free energy of cells.

M. GHOSH.

Physical Research Laboratory,
Presidency College,
Calcutta,
May, 1933.

32–Electron System of Selenium.

IN the second* of a series of papers dealing with the investigations on the successive spectra of Selenium, it was shown that 32-electron system of Selenium consists of triplets and singlets and all the terms corresponding to the deepest 4p state and the higher 5s, 4d, 5p and sp^3 states were discovered. Further investigation of the spectrum has revealed about twenty new levels assignable to the doubly-ionised atom and arising from the still higher 6s, 5d configurations. For the first time in spectra of the type under consideration, some terms are also found belonging to the 4*f* state of the valence electron.

The differences 4p $^3P_0$—*m*s $^3P_2$ are found regularly to tend, in conformity with theoretical prediction, towards the difference 4p $^2P_{\frac{1}{2}}$—$^2P_{1\frac{1}{2}}$ = 4376 cms.$^{-1}$ of the next higher ion —Se IV.†

Full details of the investigation will be shortly published elsewhere.

K. R. RAO.
S. GOPALAKRISHNAMURTY.

Science College,
Andhra University,
Waltair,
May 25, 1933.

* Investigations on the Spectrum of Se., Part II, Badami and K. R. Rao. *Proc. Roy. Soc.* (in press).

† Investigations on the Spectrum of Se., Part I, K. R. Rao and Badami. *Proc. Roy. Soc.* A., **131**, 154 (1931).

Occurrence of Free Tyrosine in the Lac Insect (*Lakshadia mysorensis*).

WHILE investigating the nitrogenous constituents from the body fluids of the lac insect, tyrosine was found to be present free, in the water soluble portion to the extent of nearly 2·5 per cent calculated on the total water soluble nitrogen. The scarlet-red, aqueous extract of the insects, is first treated carefully with the requisite amount of barium hydroxide to remove the colouring matter. The clear light-coloured filtrate is, then, treated with phosphotungstic acid which precipitates out the more complex nitrogenous bodies. On concentrating the filtrate, characteristic crystals of tyrosine separate out.

Tyrosine has been found to occur in aqueous extracts of the earthworm, in the salivary glands of cephalopods, and in the blood of the silkworm. The febrifugal property possessed by the water extract of the earthworm is attributed to the tyrosine present in the extract. The reputed anti-

pyretic quality of the aqueous decoction of the lac insect may similarly be due to its tyrosine content.

N. K. RANGA RAO.
M. SREENIVASAYA.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
June 6, 1933.

Action of Light on the Vapour of Tin Dihalides.

THE absorption spectra of Tin dihalides which I have been investigating for some time past have revealed certain unusual features which cannot be reconciled with the well-known theory of Franck. The absorption has been found to consist of several patches followed by transmitted regions. The details are given below. There is no sign of band absorption.

TABLE 1.

Substance	Long wavelength limit First cut ν_1		Long wavelength limit Second cut ν_2		Long wavelength limit Third cut ν_3	
	Angstrom units	Kilocalories	Angstrom units	Kilocalories	Angstrom units	Kilocalories
Tin dichloride	4480	69·8	3712	76·6	2858	99·6
Tin dibromide	4517	62·9	3967	71·7	3274	86·9
Tin diodide	...	...	...	...	6400	44

The values of the atomic heat of formation of $SnBr_2$ and SnI_2 are approximate, as the heats of sublimation for these salts have been extrapolated. It is seen that the energies corresponding to the three cuts bear the same ratio to the atomic heat of formation in the case of each of the salts. The correspondence is shown in table below.

TABLE 2.

Substance	Atomic heat of formation of the substance in kilocalories R	$\frac{\nu_1}{R}$	$\frac{\nu_2}{R}$	$\frac{\nu_3}{R}$
Tin dichloride ..	176	0·39	0·43	0·57
Tin dibromide ..	158	0·39	0·45	0·56
Tin diodide ..	73·5	...	...	0·60

Such a correspondence has been already found by Dr. S. C. Deb* in the case of halides of Aluminium.

Of a far greater interest are the intensity conditions of the various retransmissions, the sharpness of the cuts, and the unsymmetrical widening of the absorption regions as the density of the vapour and its temperature are varied. The following explanation is made disregarding the energy considerations. It may be modified when I have microphotographed the spectrum.

The first cut can be explained as marking the photo dissociation of $SnCl_2$ into SnCl and Cl. The SnCl molecule is in the state $^2\Pi_{1/2}$ which has been postulated by Mulliken† in explaining the band systems obtained by Jevons.‡ Those bands were attributed to SnCl. The second cut can be explained as marking the photodissociation of $SnCl_2$ into Cl and SnCl in the $^2\Pi_{3/2}$ state. The difference between these two cuts is 2385 cms.$^{-1}$, the difference between the 0-0 bands in the band systems of SnCl is 2360 cms.$^{-1}$ marking the difference between the $^2\Pi_{1/2}$ and $^2\Pi_{3/2}$ states. The agreement between the difference of the two cuts and of the two states of SnCl molecule is very good.

We are not so sure about the interpretation of the third cut and possibly a fourth cut. The following explanation is offered only tentatively. The cut corresponds to the dissociation of SnCl ($^2\Pi_{3/2}$) into Sn and Cl. If its heat of dissociation be R′, and the energy corresponding to the second cut be W, then

$$R' = R - W = 99\cdot9 \text{ K cals.}$$

The experimental value is 99·6 K cals., which is an excellent agreement.

* Deb. Absorption Spectra of some Trihalides. *Bull. Acad. Sc.*, U.P. Vol. **1**.

† Mulliken. *Phy. Rev.*, **28**, 497, 1926.
‡ Jevons. *Proc. Roy. Soc.*, A. Vol. **110**, p. 365.

Assuming the explanation for the third cut to be similar for $SnBr_2$, we find from the value of the cuts that the heat of sublimation of $SnBr_2$ should be 43·5 K cals., which seems very probable. Experiment will soon be performed for finding out the value of the heat of sublimation of $SnBr_2$ with an apparatus in this laboratory based on the effusion vapour from a small orifice.

The corresponding first and second cuts in SnI_2 have not yet been obtained as, according to calculation, they are expected to occur at $\lambda 1\ \mu$ and $0{\cdot}9\ \mu$. It will be difficult to obtain these photographically, but attempts are being made to get them.

The full paper will be published elsewhere.

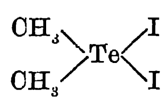
HRISHIKESHA TRIVEDI.

Department of Physics,
Allahabad University,
Allahabad,
May 20, 1933.

The Constitution of Tellurium Dimethyl Dihalides from the Magnetic Standpoint.

LOWRY AND GILBERT (*Nature*, **123**, 85, 1929) studied the magnetic properties of tellurium dimethyl dihalides and found them to be diamagnetic. From this they concluded that there could be no single electron bonds in these compounds. This argument overlooks two facts. Firstly, that Sugden postulates that the single electron bond always occurs in pairs in these molecules and the compound shows diamagnetism due to the neutralisation of the magnetic field of the electrons. Sugden's postulate constitutes a *prima facie* answer, although it is an unsatisfactory answer, as it needs to be substantiated by some independent physical evidence, such as association of the molecule twice or an even number of times. The second fact which has been overlooked is that the total diamagnetic contribution of the constituent molecules may mask the paramagnetic effect of the singlet linkage and hence the value of χ at one temperature would hardly yield any conclusive evidence on the point under discussion.

Further, it also seems certain that in a compound like



the single electronic bonds should be at an angle and thus have a resultant magnetic moment.

We have, therefore, investigated the thermal variation of χ for $(CH_3)_2.TeBr_2$, $(CH_3)_2.TeCl_2$ and $(CH_3)_2.TeI_2$ and $(CH_3)_2.Te(NO_3)_2$. We find that the change of χ with temperature is negligible and so it eliminates the possibility of a masked paramagnetic configuration in these compounds. We have also employed the method of arriving at the structure of compounds by comparing the calculated and experimental values of χ after the manner of Angus and Farquharson (*Proc. Roy. Soc.*, **A. 136**, 1932). The theoretical values were computed from Pascal's data introducing constitutive correcting factors for dihalides and using all chemical bonds as simple two electron bonds. The following table gives the comparison:—

	χ (Specific) Calculated	χ (Specific) Experimental
$(CH_3)_2.TeBr_2$	0·40	0·37
$(CH_3)_2.TeCl_2$	0·47	0·42
$(CH_3)_2.TeI_2$	0·37	0·36

There appears to be a fair agreement between the calculated and experimental values. There are practically no differences which can be attributed to single electron linkage and it appears that all the valencies are fully satisfied. From this and the experiments on the thermal variation of χ it appears probable that single electron bonds do not exist in these compounds.

A detailed account of the work will be published elsewhere.

S. S. BHATNAGAR.
T. K. LAHIRI.

University Chemical Laboratories,
University of the Punjab,
Lahore,
May 1933.

Dilatometric Study of the Hydrolysis of Glycine Anhydride.

THE hydrolysis of glycine anhydride by alkali has been studied in the new dilatometer described by Sreenivasaya and Sreerangachar (*Jour. Indian Inst. Sci.*, 15A., 17, 1932). 10 c.c. of a 1 per cent solution of

glycine anhydride, prepared from glycine-ethyl-ester-hydrochloride, and 50 c.c. of 0·1 N sodium hydroxide, formed the reaction mixture. On mixing the solutions in the dilatometer, there occurs an increase in volume which is strictly proportional to the increase in dipeptide carboxyl as determined by Sorensen's formal titration. The amount of anhydride hydrolysed can, therefore, be determined from the dipeptide that is estimated. The volume change per gram molecule of the anhydride, hydrolysed to dipeptide in solution, is calculated to be 7·57 c.c. As the anhydride in solution exists in the diketo form, the above constant corresponds to the cleavage of the diketopiperazine ring.

The study is being extended to the enzyme hydrolysis of simple peptides, peptones and proteins.

M. SRINIVASAN.
M. SREENIVASAYA.
Department of Biochemistry,
Indian Institute of Science,
Bangalore,
June 6, 1933.

Animals in Brackish Water at Uttarbhag, Lower Bengal.*

By Dr. Sunder Lal Hora, D.Sc., F.R.S.E., F.L.S., F.Z.S., F.A.S.B.,
Zoological Survey of India, Indian Museum, Calcutta.

ON the 2nd of January, in an attempt to proceed to Port Canning from Calcutta by car to study the fauna of brackish pools investigated by Annandale† in 1907, I was held up near Uttarbhag on the western bank of the Piali Nadi, which could not be crossed. Though greatly disappointed at the time, we started to collect the fauna of the pools and ponds. The north end of the pond behind the "paddy" market and nearest to the road did not yield anything of unusual interest, but as we proceeded further afield, the behaviour of the fauna of the small pools and their dried-up beds provided a fascinating subject for investigation, especially the adaptations of organisms to drought and the consequent increase in salinity and foulness of the water. On account of heavy rains in the month of November 1932, there was a few inches of water in a number of comparatively shallow pools. During our subsequent visits in February and March, it was noticed that the pools had dried up completely and the water of the larger pond had fallen considerably lower. Up to the end of March, I paid four visits to the place and twice it was visited by the assistants separately (Fig. 1). The following preliminary observations on the fauna are the result of the scanty collections made during this period. The visits were mainly intended to make detailed observations on certain animals, and these will be published elsewhere at some later date.

Uttarbhag is about 23 miles from Calcutta and 5 miles beyond Baruipur; it is thus seen that the place is quite low down in

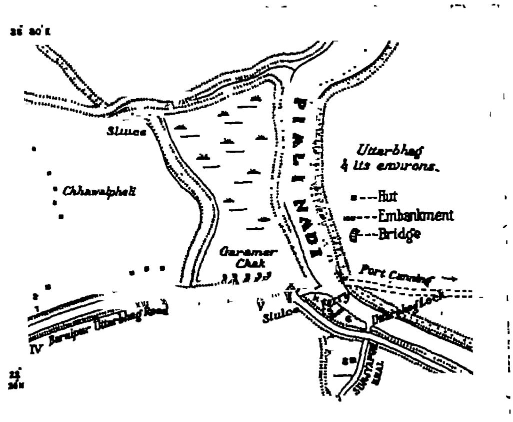


Fig. 1.

A sketch map of Uttarbhag and its environs, showing the position of the pools and ponds investigated.

1. Pools on the north side of the Baruipur-Uttarbhag road opposite milestone IV (fig. 4); 2. pond (fig. 5); 3. small, enclosed fisheries in front of a line of huts; 4. big pond behind paddy-market (fig. 6); 5. a series of deep pits (fig. 7); 6. shallow pools below the embankment (fig. 8); 7. a vast lake-like expanse of water; 8. paddy-field (fig. 9).

the deltaic region of the Ganges. Its importance lies on account of its situation on the western bank of the Piali Nadi, one of the numerous creeks which run up into the delta of the Ganges, and on account of the fact that it is connected with Calcutta by means of a tolerably good cart road:

* Published with permission of the Superintendent, Zoological Survey, India.

† Annandale, *Rec. Ind. Mus.*, **1**, 35–45 (1907).

The Piali Nadi is a tidal creek connecting the Bidyadhari and the Matla rivers; it is about 32 miles in length and its width varies from 1,500 feet in the lower reaches to 400 feet near the Piali Railway Bridge. The river is embanked on both sides, so that normally its water does not now spill over into the adjoining lands. The rise and fall of the river due to tides at this place is approximately 15 feet. During the first phase of the high tide on the 13th of March the salinity of its water was estimated to be 18·08 per mille, and a sample of water taken about the middle of February at ebb tide showed a salinity of 12·30 per mille.

During the ebb tide, when the river banks are exposed (Fig. 2) it is noticed that they

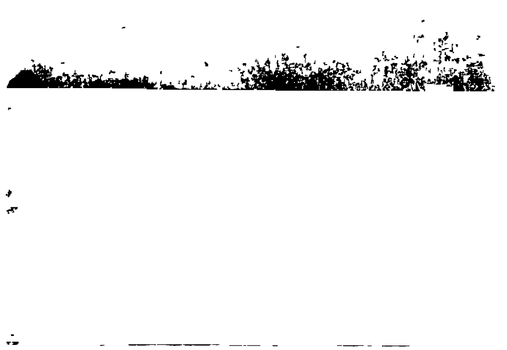


Fig. 2.

The Piali during ebb tide.

Notice the people going up and down from and to the ferry-boat respectively along the exposed, slanting and muddy bank of the river. The dark area represents the highest water level.

are lined with very fine and soft mud, into which boys sink knee-deep as they go about collecting fish and crustacea. Here *Onchidium*, a slug-like Gastropod mollusc, may be seen in countless numbers crawling about on the soft mud, on stems and leaves of vegetation or on anything that may be lying on the shore. On account of the mud-like colour of its dorsal surface, it is rather difficult to detect by unaccustomed eyes. These molluscs come right up to the highest water level, but are not to be found on the dry surface. Lower down the bank, not very far from the stream of water, the mud-skipper *Periophthalmus schlosseri* attracts one's attention as it hops about on the mud. Here it may be seen entirely out of water, so that the phenomenon of caudal respiration in reference to these fishes has to be regarded as a myth. *Periophthalmus* is a very active and watchful fish. On the approach of any object, it burrows in the soft mud, but it cannot stay there for long because it must come up to take a gulp of air for respiration, the air being stored in the gill-chambers. There are three other Gobioid fishes—*Boleophthalmus boddærti*, *Tænioides rubicundus* and *Pseudapocryptes lanceolatus*—that live in this habitat. These are also capable of breathing atmospheric air direct and of storing it in their gill-chambers for respiratory purposes (Fig. 3).

Fig. 3.

Boleophthalmus boddærti (Pall.)

Notice the bulging gill-chambers in which air is stored for respiratory purposes.

They are, however, not so active as *Periophthalmus* and prefer to lie in burrows when the tide goes out. The boys know their habits and catch them very easily. In a small pool on the bank a few specimens of *Glossogobius giuris*, *Mugil parsia*, *Aplocheilus melastigma*, *Panchax panchax* and *Aoria gulio* were taken. From the flowing water the boys had collected a number of the carp

Barbus sophore. The clumsy-looking, large-clawed, asymmetrical crabs of the genus *Uca* (=Gelasimus) were also common in burrows in the soft mud, while in the water the swimming crab, *Scylla serrata*, is fairly abundant.

The animals that live on the banks are subject to immersion or desiccation with the rise and fall of the river for prolonged periods.

From a sketch of the fauna of the Piali Nadi given above it may be noticed that most of the animals are typically brackish water, while the species of fish, like *Barbus sophore*, *Aoria gulio*, *Aplocheilus melastigma* and *Panchax panchax*, are primarily fresh-water species. Lt.-Col. R. B. S. Sewell has worked out the Copepods from the stream, and he also found a mixture of the freshwater species with the typically brackish water fauna of the stream. I have referred to the animals of the Piali Nadi at some length, for in studying the fauna of the ponds and pools we shall notice how these animals have now colonised the neighbouring smaller pieces of water where the conditions of existence are very hard. In Lower Bengal the rainy season lasts from the middle of June to the end of September, and during these months the country is flooded. Then the dry season sets in which lasts till the end of March. A few thunderstorms bring some rain in April, but after this for a couple of months the dry conditions prevail. During these months the animals are subjected to drought and intense heat. The salinity must also change considerably under such weather conditions. With these preliminary remarks we will now consider the fauna of the ponds and pools investigated at Uttarbhag in the order in which one meets them when travelling from Baruipur.

After travelling three miles beyond Baruipur the country opens out and vast stretches of "paddy" fields are seen on both sides of the road, which runs on a high embankment. On both sides of the embankment between it and the adjoining rice-fields, there are belts of low-lying land, about 30 to 40 feet wide, probably excavated when the embankment was made. Even now deep burrow-pits are made on the sides when the embankment is repaired. During our visit on the 8th of February, these low portions had at intervals small rounded patches where the surface was still damp and the mud soft, or where a few inches of water still formed a shallow pool (Fig. 4). Such was the condition of the low-lying belt on the north side of the road opposite milestone IV. The salinity of the water in the pools varied from 9·24 to 10·05 per mille. The bottom mud of the pools was full of the

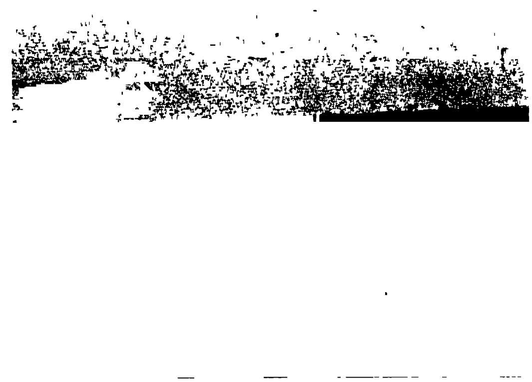


Fig. 4.

A belt of low-lying land with a series of pools between the road-embankment and the adjoining rice fields near milestone IV on the Baruipur-Uttarbhag road.

Amphipod, *Grandidierella bonnieri*,* which was making burrows freely in the soft mud. Burrows of the Amphipod could also be seen on the bed of the pools where the water had just dried up. Along with the Amphipod a single specimen of a remarkable Isopod of the family Anthridæ (*Flabellifera*) was also collected. The bivalve *Cuspidaria* and the Gastropod *Melanoides* were also common at the bottom. A large number of young fish were swimming about in the pools. Most of these were *Aplocheilus melastigma*, but a few specimens of *Barbus sophore*, *Esomus danrica*, *Glossogobius alcocki* were also obtained. The crab, *Varuna litterata*, was most abundant in the pools and in their immediate neighbourhood. In a pond close by (Fig. 5) the banks were honey-combed with the burrows of this species. As the dry season advances and the pools dry up, the surface of the mud bottom becomes cracked into slabs about 6 to 9 inches deep, which become detached from the damp mud below. These cracks provide shelter for the *Varuna* crabs, but when the inner surface of the crack dries up, they make deeper burrows into the still soft, damp mud.

* For the identification of this and other Gustacea I am indebted to my colleague, Dr. B. N. Chopra.

As one proceeds towards Uttarbhag the channels on the sides of the embankment contain more and more water, till on the north side of the road in front of a line of huts one sees a number of small enclosed fisheries. On the 16th of March, when the water had fallen very low, the salinity of the water was 17·61 per mille. Besides the

Fig. 5.

Pond near milestone IV, Baruipur-Uttarbhag Road (clouds are reflected in water).

Notice that the bank is honey-combed with the burrows of the crab, *Varuna litterata* Fabr.

fish enumerated above, *Aoria gulio*, *Ophiocephalus striatus* and *Ambassia ranga* were also found here. The commonest species was *Barbus sophore*. *Varuna litterata*, *Metapeneus brevicornis* and *Palæmon lamarreii* represented the Decapod crustacea. The species of Amphipod noted above was also common here in the mud. One most interesting feature was the presence of the burrows of the crab, *Sesarma tetragonum*. The crab makes its burrows in the high banks of the water channels, and it digs its burrow to a depth of 6-7 feet or even more to reach the level of the subsoil water. The salinity of the water taken from the bottom of the burrow was found to be 11·31 per mille. There is a sluice at the head of the channel on the south side of the road, and it seems likely, therefore, that these channels are sometimes fed by the water of the Piali Nadi. There is considerable leakage of water through the sluice even when this is closed. Similarly the channels on the north side of the road are fed from a sluice about a mile and a half about Uttarbhag.

After crossing a small bridge we got to the principal market of the village and the ferry ghat. Behind and between the huts and the embankment running to the lock of the Surjyapur Khal there is a big pond (Fig. 6) or rather a series of ponds connected

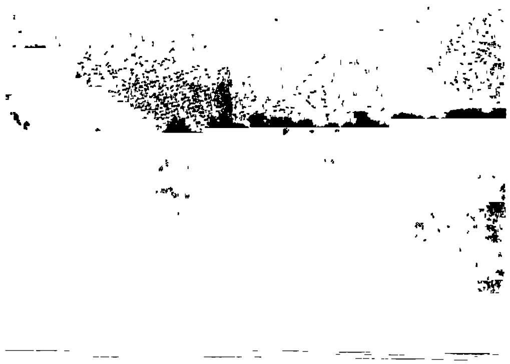


Fig. 6.

Large pond behind the paddy-market at Uttarbhag.

with one another by means of channels in which fish traps are placed at suitable places. By means of a narrow channel this stretch of water is put in communication with that of the Piali Nadi. At high tide the water from the river flows into this pond, while the current is reversed at the ebb tide. As has been indicated above the north side of the pond had nothing of unusual interest, but on the south side *Periophthalmus schlosseri* was present in all channels and drying up pools. *Pseudapocryptes lanceolatus* was also common in soft mud, and when the pools dried up it burrowed to depths of 5 to 6 feet. Some specimens were dug up in a more or less comatose condition. On the damp surface, *Onchidium* were also found crawling about. When digging up fishes, at a depth of 4 feet, a Polychæte worm—*Nereis (Nereis) glandicincta* Southern—was found actively crawling about in the mud. It is a brackish water species and has so far been recorded from the Salt Lakes near Calcutta, Vizagapatam and Tale-Sap in Siam. Its parapodia are peculiar and are probably adapted for burrowing in soft mud. Its fassigerous bristles are provided with long knife-like terminal pieces. Even in water the movements of this worm are very rapid. In the soft mud oligochæte worms were also present. On the 2nd of January the salinity of water on the north side of the pond was 4·16 per mille.

Between the narrow channel connecting the large pond with the Piali River and the

huts there is a series of deep pits (Fig. 7) from which mud seems to have been taken for building purposes. During our first visit some of these were dry, while there was a few inches of thick, foul-smelling water in others. From one of these a specimen of

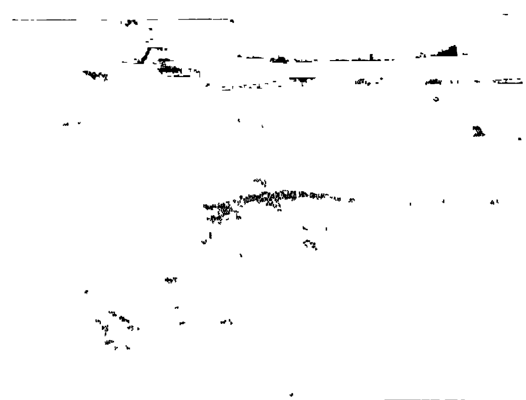


Fig. 7.

Deep and drying-up pits to the south of the paddy market just behind the huts.

Mugil parsia, nine inches in length, and a specimen of *Aoria gulio* were taken. *Onchidium* crawling on the damp surface, *Periophthalmus* hopping about and Amphipods burrowing in mud were the other characteristic animals of these pools. A dried-up pool was dug up and one specimen of *Periophthalmus*, a few *Varuna* crabs and two specimens of *Pseudapocryptes* were taken out. This also shows that the belief that the respiration of *Periophthalmus* can be and is carried on by the tail, which is kept in the water, must be treated as a myth. Attention may here be directed to the curious fact that a large number of the empty burrows of *Pseudapocryptes* contained young examples of the Python, *Python morulius*. Whether these young snakes had eaten the fish or had entered empty burrows could not be ascertained.

A few paces beyond these pits, and after crossing an embankment, is a small piece of land which is overgrown with a species of a small xerophytic plant, *Suæda maritima*. At exceptionally high tides the water from the Piali Nadi flows in one or two places over the embankment and floods this land. Below the embankment to the Surjyapur Khal, there is a series of shallow pools (Fig. 8), probably the remnants of the old burrow-pits. The flood water accumulates in these pools. During the four visits, I have seen them both full of water and in an almost dry condition. Probably they receive the Piali water at the spring tides and dry up in the intervals between them. The fauna was the same as that of the pits described above and when a portion of a pool was dug up, a *Periophthalmus* and a few *Varuna* crabs were taken out. Two

Fig. 8.

A series of shallow pools below the embankment to the Surjyapur Khal.

days after the spring tide on the 16th of March the salinity of the water was estimated to be 18·40 per mille.

On the other side of the embankment is a lake-like stretch of water which is connected with the Surjyapur Canal on the south side and ends blindly on the north side. About the middle of March its salinity near the north end was 6·28 per mille. We were fortunate enough to see it being fished with large nets. *Lates calcarifer*, *Labeo rohita*, *Cirrhina mrigala* and *Catla catla* were the principal food fishes that were being collected. Among the smaller species we found *Barbus ticto*, *B. sophore*, *B. gelius*, *Aoria gulio*, *Panchax panchax*, *Aplocheilus melastigma*, *Trichogaster fasciatus*, *Ambassis ranga*, *Pseudapocryptes lanceolatus*, *Ctenogobius alcocki* and *Butis butis*. In the adjoining paddy-field some boys were collecting fish in small pools of water (Fig. 9). The salinity of the water was 4·38 per mille and it was smelling strongly of sulphuretted hydrogen. The catch of the boys consisted of the *Varuna* crab, four species of prawns—*Metapeneus monoceros*, *M. brevicornis*, *Cardina propinqua* and *Palæmon lamarreii* and

15 species of fish—*Aoria gulio*, *Barbus ticto*, *B. sophore*, *Esomus danrica*, *Xenentodon cancila*, *Panchax panchax*, *Aplocheilus melastigma*, *Mastacembelus pancalus*, *Ophiocephalus striatus*, *O. punctatus*, *Anabas testudineus*,

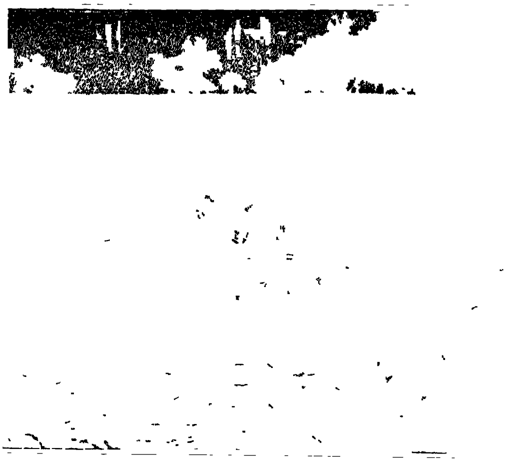


Fig. 9.

Boys catching fish in a drying-up portion of a paddy-field.

Nandus nandus, *Ctenogobius alcocki*, *Glossogobius giuris* and *Pseudapocryptes lanceolatus*. A couple of days after our visit these pools dried up altogether and when a portion was dug up a few *Varuna* crabs were found æstivating.

From the above brief and incomplete sketch of the animal life in brackish water at Uttarbhag it is clear that a number of freshwater species, such as Cyprinoid fishes, have migrated into brackish water and can now stand a salinity half as much as that of the sea water. On the other hand, the characteristic marine fishes, such as the Gobies, have migrated upwards into brackish water. The main interest of the brackish water fauna lies in the fact that it comprises peculiar and highly adaptable forms, which seem to have been derived from both the marine and the freshwater elements of the adjoining regions. This animal association shows great adaptability to changes in salinity, partial or complete drought, muddy water, soft and muddy bottom, etc. It has been stressed by several observers, and there is no reason to disagree with them, that the estuarine regions serve as the nurseries for the evolution of the true freshwater fauna, and it is universally believed that life originated in the sea and even now it is most prolific and diversified in the salt waters. In the regions, such as that described above, the evolution of the freshwater fauna can be followed even to-day and the various factors that brought about this fundamental change can be studied.

A Suggestion as to the Origin of Tornadoes in Bengal.

By Dr. A. K. Das, D.Sc.,
Alipore Observatory, Calcutta.

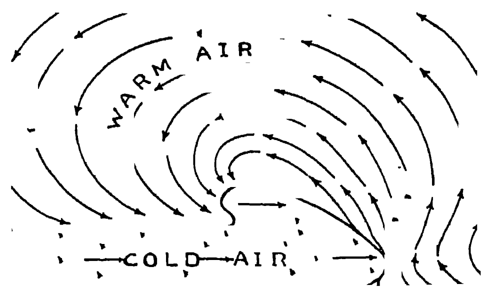
In a paper, which is to appear shortly in the *Gerlands Beiträge zur Geophysik*, I have dealt in detail with the mechanism and the mode of propagation of thundersqualls which are common in Bengal, particularly in the early summer and the autumn months. The mechanism put forward there has been shown to explain all the important features of these well-known squalls; in particular the velocities of nor'wester squalls have been theoretically calculated from the observed sudden rise of barometric pressure and fall of temperature accompanying these squalls in a large number of cases chosen at random from the meteorological records of the period 1905-1932. Assuming that a thundersquall is the process of sudden replacement of the existing warm air by a sample of cold air so that the rise of pressure observed at the onset of a thundersquall is due to the weight of the layer of cold air which flows underneath the warm air, the velocity (V) of propagation of a thundersquall is given by the following relation:

$$V = \tfrac{2}{3}\sqrt{\frac{2RT^2}{T'} \cdot \frac{\Delta B}{B}},$$

where R=the usual gas constant, T′=temperature of the warm air, and T=temperature of the cold air, B=barometric pressure before the onset of the squall and ΔB=rise of pressure during the squall. In deriving the above formula the vertical gradients of temperature in the two samples of air have been neglected. But the formula can easily be modified to include the temperature lapse-rates, in which case pressure is eliminated from the formula. It has been found

that there is a good agreement between the velocities calculated with the help of the above relation and the velocities actually recorded by anemographs. A method of forecasting the velocities of the squalls as well as the direction of their motion has also been indicated in the paper referred to above. It has, moreover, been shown that the same mechanism, although put forward primarily to explain those thundersqualls which are accompanied by a sudden rise of barometric pressure and a simultaneous fall of temperature, explains in quite a natural way the different types of temperature changes recorded during thunderstorms not only in Bengal, but in other parts of India as well.

In this note I wish to outline the process of formation of a tornado (or waterspout) on the basis of the mechanism proposed for thundersqualls, and for this purpose I shall first briefly state the main points of this mechanism. The principal constituents of a thundersquall, as is well known, are a cold sample of air and a warmer (and therefore lighter) sample, the colder air moving under favourable circumstances into the region occupied by the warm air. Once the motion is started it will continue till the cold air penetrates, due to its higher density, under the warm air which will therefore be forced to rise. According to this mechanism the penetration of the cold air will have all the essential properties of a cold wave and will take place in the same way as observed by W. Schmidt in his idealised laboratory experiments; in other words, the cold air will develop a "hump", or squall-head, so that the warm air will be vigorously forced up in the front of the cold air and after passing over the top of the squall-head it will come down in its rear. This motion will therefore tend to produce a whirl with a horizontal axis in the upper air in the rear of the squall-head. It may be mentioned here that this point of view is strongly supported by the peculiar shape of the squall-head as obtained by Schmidt in his laboratory experiments (see Fig. 1) as well as by the characteristic anvil form of some cumulo-nimbus clouds. That the advance of cold air from one part of the atmosphere into another takes place in such a way that the discontinuity surface is steepest in the front of the cold air and not uniformly sloped as would be suggested by the idea of a cold air "wedge" is a well-known fact verified by the observations of G. Stuve and others. Also the usually observed formation of rain clouds in the front of advancing cold air and the clearing of the sky after the passage of the cold front would receive a natural explanation from the ascent of warm moist air in the front and its descent in the rear of the squall-head. If the temperature contrast between the two air samples is sufficiently sharp a complete whirl can be



formed and be maintained for a long time since it can draw its supply of energy from the cumulo-nimbus cloud inside which it is formed. This whirl with horizontal axis is probably the "mother vortex" responsible for the occurrence of tornadoes (or waterspouts) in Bengal in association with the nor'wester squalls. It is to be remarked that the existence of a steep or superadiabatic temperature gradient prior to the advance of the cold air would add to the intensity of the whirl brought about by the mechanism of squall-head, although a steep or superadiabatic gradient does not by itself necessarily cause an overturning of the strata. It may be mentioned, however, that it is not necessary that the motion of the cold air should always take place along the ground; there may be a similar motion of cold air from one part of the free atmosphere to another giving rise to the "mother vortex", so that although nothing striking is noticeable on the synoptic weather maps a tornado may occur simply as the result of conditions in the free atmosphere. On many occasions, however, sharp contrasts of temperature (and perhaps sharp discontinuities in other meteorological elements also) should be noticeable in the horizontal as well as vertical directions. The absence of pronounced indications on the surface weather charts before the occurrence of certain tornadoes should not be surprising, for a tornado is essentially an upper air phenomenon which eventually affects the ground level under favourable conditions.

As a matter of fact, tornadoes with a horizontal trunk, which does not reach the ground level at all, have occasionally been observed in Europe (*e.g.*, the tornado of 16th May 1887 at Teplitz).

From a study of over 250 tornadoes in Europe, A. Wegener[1] came to the conclusion that the tornado has its origin in a whirl with horizontal axis, which he calls the "mother vortex", formed inside the giant cumulo-nimbus which accompanies the tornado. The manner in which objects are carried high up in the atmosphere by a tornado, first in a more or less vertical direction and then horizontally till finally they are thrown down on the earth at a considerable distance from where they were picked up, can be satisfactorily explained by the idea of the "mother vortex", whose horizontal axis ultimately bends down at the ends towards the ground. It is easy to see that the whirl, which should sometimes come into being as a result of the mechanism of Bengal thundersqualls indicated above, should have properties very similar to those of Wegener's "mother vortex". In Bengal the warm moist air which is lifted by influx of cold air in a thundersquall blows from a southerly direction. The whirl which forms in the lee of the squall-head should therefore move in a northerly direction approximately opposite to the direction of motion of the cold air. The exact direction of displacement of the whirl will, of course, be considerably influenced by the prevailing upper winds. If in a particular case the cold air travels from north-east towards south-west, the axis of the whirl will be approximately in N.W.—S.E. direction, so that looking from south-east the rotation of the whirl will be clockwise, while looking from north-west it will be counter-clockwise. If now the ends of the whirl bend downwards we have two more or less vertical vortex pipes, one on each side of the cumulo-nimbus tower, which should form approximately on the top of the squall-head. The vortex pipe on the right-hand side is the one that usually constitutes the tornado, probably because the existence of a convergence line on this side favours its formation; the vortex pipe on the left does not seem to have yet been observed with certainty. Looking in the direction of motion of the warm current, therefore, the vortex pipe on the right-hand side of the cumulo-nimbus tower would have (looking as usual from above) an anti-clockwise rotation, with air ascending, while the one on the left, if it does form, would have a clockwise rotation with air descending towards the ground.

Since there is no *prima facie* reason for believing that the tornadoes of India are different in their mechanism from those of Europe, it appears very probable that the tornadoes which occasionally form in Bengal in association with thundersqualls owe their origin to the mechanism suggested above. Unfortunately, no observations are available for Bengal tornadoes and there is no established theory about them. In order to test the tentative mechanism of the origin of tornadoes in Bengal put forward here or to evolve a satisfactory theory it would be essential to make not only a careful and systematic investigation of the areas of destruction with a view to finding out the nature of the wind motion in different tornadoes, but also regular observations of the barometric and thermal structure of the atmosphere at a large number of stations. The upper air instruments which I have described elsewhere[2] should be of considerable help in this matter; but the co-operation of the scientifically inclined public in making visual observations would greatly advance the cause of tornado research in Bengal, particularly with a view to determining the way in which objects are carried up and thrown about by tornadoes, and also how the areas of rainfall are situated with respect to the path of destruction.

[1] A. Wegener. *Wind und Wasserhosen in Europa*, 1917.
A. Wegener. *Met. Zeit.*, 1928, S. 201.

[2] A. K. Das. *Gerl. Beitr. z. Geoph.*, **36**, 1, 1932.
A. K. Das, B. B. Roy and D. N. Das Gupta. *Ibid.*, **36**, 4, 1932.
A. K. Das. *Ibid.*, **37**, 224, 1932.

On the Bionomics, Structure and Physiology of Respiration in an Estuarine Air-breathing Fish, *Pseudapocrytes lanceolatus* (Bloch and Schneider)

With Special Reference to a New Mode of Aerial Respiration.

By Dr. B. K. Das, D.Sc. (London),

Professor of Zoology, Osmania University College, Hyderabad (Deccan).

IN his monograph on the air-breathing fishes in the *Phil. Trans. Roy. Soc., London*, 1927, the author has given a fairly complete account of the structure, development and physiology of a certain interesting group of air-breathing fishes of India. A general account of the habits and the curious mode of aerial respiration (hitherto unknown) of this estuarine Gobiid was submitted by the same author at the two meetings of the Indian Science Congress held at Allahabad (1930) and at Bangalore (1932), which has already been published in the Proceedings of the said Congress. The following is a summarised report of the outstanding facts contained in his elaborate paper which has been sent for publication elsewhere:—

(1) *Pseudapocrytes lanceolatus*, commonly called 'Goolay' in Bengal, is a small, eel-like estuarine Gobiid (Fig. 1, *a*, *b* & *c*) about 15·2 cms. in length and with a maximum girth of 5·6 cms., having very slippery skin with minute cycloid scales, and often residing in muddy localities and also in burrows situated near water, æstivating* during the hot months, very similar in habits to another fresh and brackish water fish *Amphipnous cuchia*. The fish was procured from the estuarine parts of Bengal, *viz.*, Port Canning and Diamond Harbour, within an easy reach from Calcutta. It can also be had plentifully during the months of October and November from the Calcutta markets. The fish possesses a non-cellular physoclistous type of air-bladder. The habit of æstivation is generally prevalent amongst air-breathing fishes as described by the author in 1927, and it is an adaptation to avert drought when the small sheets

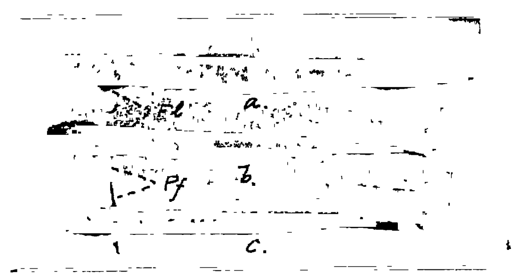


Fig. 1.

(*a*, *b* and *c*)—Representing lateral, ventral and dorsal aspects of *Pseudapocrytes lanceolatus* respectively. Fl=Ventral "disc" (*i.e*, the united ventral fins). Pf=Pectral fins.

of water in which these fishes are confined usually dry up (*cf.* Burrowing habits of Dipnoi due to similar environmental conditions and especially the vitality of the African genus, *Protopterus*, which could lie dormant in its cocoon for nearly five months are quite well known‡).

(2) The opercular chamber is a small sac-like structure supported by very thin and elastic opercular bones, and the gill-opening is quite narrow, about 8 mm. in length. The closing of this opening is due to the sticky secretions poured by the innumerable number of mucous glands present along the opercular rim as well as to the pressure caused by the forward rotation of the fleshy lobe of the pectoral fin (Pf).

(3) Biserial type of gills is present, but the 4th gill is extremely small. In addition each primary gill-filament is divided into several very small leaf-like secondary filaments (not so prominent in purely water-breathing fishes), evidently meant to present a larger area as well as to make a more

* Fishes (no matter whether brackish or freshwater forms) generally spending most of their life in muddy localities (and the same thing being too well known in the case of such remotely distributed fishes as the Dipnoi living under similar environmental conditions) are obliged to adopt such a mode of life in order to avoid death when the liquid mud periodically dries up during summer, and hence if such fishes are to survive at all and to make their life a success by leaving their progeny and so to continue their race, then they must take recourse to some means to escape death and extinction, and, therefore, the easiest way for them is to get themselves buried inside the wet mud and remain in burrows for some time in a state of torpor until such time as the rains set in and again resuscitate them once more from their summer sleep. (Day, 1868; Dobson, 1874; Das, 1927) [*cf.* Discussion part of the original paper.]

‡ [*Cf.* Discussion part of the original paper.]

efficient mechanism for the absorption of as much oxygen as possible present in the surrounding medium, which is usually very deficient in oxygen.

(4) When the water is dirty (that is to say, poor in oxygen), the fish occasionally comes to the surface to breathe in atmospheric air directly. The inhaled air is retained in the opercular chambers, which become bulged out like two little "bladders" (*cf.* Pharyngeal "lung" of *Amphipnous*, Das, 1927) on the sides of the head, and in this position the fish floats about *passively* (generally 2-4 minutes), with stretched out pectoral fins, almost lying vertically upwards (Fig. 2), probably due to the buoyancy caused by the air-filled chambers, and from a distance every one appears as if it is a dead fish. These are analogous with the bladder-like structures of *Amphipnous* but not homologous with them; they are, however, homologous with opercular "lung" of other air-breathing fishes described previously (*cf.* Das, 1927). In clearer water, however, the frequency to snap air becomes reduced. The fish is usually very shy, and wriggles back quickly to the bottom after getting rid of the contained air from the opercular cavities should any disturbing element approach it. Confined in an aquarium containing dirty water the fishes are very often observed to push one another and make vigorous attempts to reach the surface in order to breathe air, and under such circumstances some are found even clinging to the sides of the vessel far above the water level (Fig. 3).

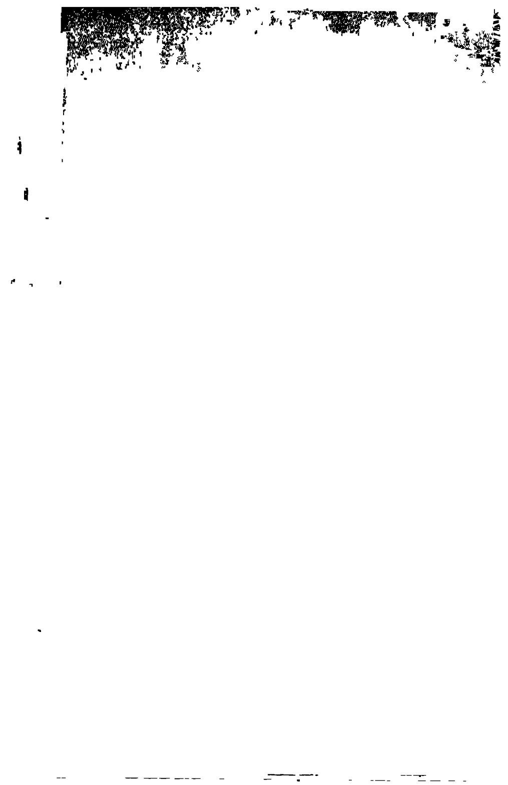


Fig. 2.

The usual attitude of the fishes in a glass aquarium, hanging almost vertically upwards with their air-filled opercular chambers and passively moving about due to buoyancy.

Fig. 3.

Same fishes confined in dirty water in a bucket and two of them seen popping out nearly 2 inches above the level of water and clinging to the sides of the vessel on the left, having their opercular chambers (Op. ch.) bulged out with inhaled air, whilst others are vigorously struggling for air, and look like so many large tadpoles. Wl=Water level.

(5) The used-up air is got rid of from the mouth, unlike the majority of the air-breathing fishes (Das, 1927), with a certain force due to which a clicking sound is produced as in *Amphipnous*. The air is forced out due to the collapse and pumping out action of the opercular chamber owing to the elasticity of its own walls (as in *Amphipnous*) and at the same time assisted by a spring-mechanism associated with ceratohyal and the last branchiostegal ray.

(6) The opercular chamber and the mouth-cavity are highly vascular, and this state of affairs, particularly associated with the latter, must be responsible to a very large extent for the *bucco-pharyngeal* respiration taking place in this fish. This phenomenon, however, is much less marked in the great majority of the air-breathing fishes, except in *Ophiocephalidæ*, *Periophthalmus* (the "Walking Goby") and *Hypophthalmichthsy* (Rauther, 1910).

[t has been observed that in fishes opercular chambers are slightly vas- they have been found to survive for st some time out of water (*e.g.*, certain r species of the fresh-water genera of such as Macrones and possibly many). This kind of structural modifica- ndoubtedly prepares an initial ground rial respiration. In addition there are other purely water-breathing fishes an live for a long time out of water igh they possess no special air-breath- gans. Many coastal fishes such as *ohthalmus* and *Boleophthalmus* and have also been discussed.

If certain weeds are placed in the ium they push their way through the s in between those weeds, hang on to with their widely spread out pectoral ultimately lift their heads above the e of water (looking like so many large les) with the object of breathing at- ieric air, which they do quite vigo- r.

While lying at the bottom in clear they perform the usual branchial ation—the branchial oscillations vary- rom 70-80 per minute under normal tions. In this position they sometimes reep about due to the alternate to and iovements of their pectoral fins. The becomes very much excited, and the hial oscillations are accelerated, if it is luced in muddy water.

) Locomotion on land in a serpentine ier (more or less like *Amphipnous*) is ed by the sculling action of the pectoral nd at the same time the ventral "disc" 1. Fl) acting as a fulcrum and also to ry large extent assisted by the lateral ns of the tail. Occasionally the fish gles over the ground and makes jerky due to the beating and spring action of ail, and this performance coupled with slippery skin of the fish enables it to i its natural element quickly. It can ve for nearly two hours out of water in utely dry condition, temperature of air ;, on average, 86°—94°F. or sometimes more.

) The opercular chamber is innervated ie fine ramifications of the ramus hyo- libularis.

!) In correlation with the initiation of a ar air-breathing habit influenced by liar environmental factors (mainly low nsion of water) several very interesting tural modifications and functional adaptations have evolved in this fish, especially with regard to its vascular system, *viz.*,

(*a*) Highly vascular character of the buccal cavity as well as the opercular chambers.

(*b*) The presence of a large number of secondary gill-filaments in the gills means (like the villi of the alimentary canal) an effective mechanism for the absorption of as much oxygen as possible from the surrounding water which usually holds very little of the dissolved gas.

(*c*) Bucco-pharyngeal respiration is evidently effected by the vascularisation of the buccal cavity: blood is taken to this region and also to the opercular chamber by an artery, equivalent to the so-called "Hyoidean" artery of *Neoceratodus* (which divides into two, *i.e.*, the *afferent buccal* and the *afferent opercular* respectively) given off from the 1st afferent branchial vessel. Besides, the 2nd afferent also makes contribution of a certain part of its impure blood to these areas for the purpose of purification.

(*d*) The blood after being purified at the mouth-cavity and the opercular chambers is drained by means of the factors of the *jugular vein* which thus carries the *mixed* blood directly to the heart.

(*e*) Mixed, *i.e.*, already partly oxygenated blood, therefore, circulates in the heart, and is then pumped to the gills for purification. This mode of circulation of the previously *partially aerated* blood in the gill-capillaries must have evolved as a special adaptation with a view to cope with the oxygen-deficiency of the surrounding water, or else the fish would die of asphyxia. This is a very unique adaptation indeed, and is resorted to by a great majority of the air-breathing fishes. In the case of *Amphipnous cuchia* and *Monopterus javanensis mixed blood circulates even in the dorsal aorta* (*cf.* Amphibians and Reptiles). Of course, amongst fishes the vascular system of the Dipnoi, as is very well known, is most highly evolved, and approaches very near the condition existing in Amphibians, and the physiology of circulation in these Indian air-breathing fishes is certainly a great advance over the one existing in the common teleostean fishes, and is undoubtedly an outcome of the reaction to their environment.

(13) A series of physiological experiments have been carried on subjecting the fish to varied conditions of water (such as muddy or foul water having low O_2-tension), noting

down its movements and behaviour in absolutely dry conditions as well as certain causes and circumstances under which asphyxiation takes place (the period of "drowning" being much greater in this fish than in all other air-breathing fishes so far recorded by the author).

(14) Apart from the branchial respiration taking place normally amongst fishes, a habit of breathing atmospheric air directly is at first very slowly acquired by some of them living under very abnormal conditions of water, that is to say, its low O_2-tension. This habit becomes gradually ingrained in the species, and then becomes intensified in course of generations. The possession of various types of air-breathing organs in fishes, which have certainly evolved quite independently, showing different degree of modifications and complexity of structure, is really an index of the magnitude of the reaction to environment, leading towards the amplification and intensification of such a habit in different fishes which have adapted themselves to various conditions of life. "*Habit after all is second nature, and nature is only a name for first habit.*" We can thus picture in our minds as to how physiologically equivalent structures could possibly evolve under the influence of similar environmental factors, governed by similar natural forces, a case of parallelism in evolution in so many remotely related fishes, inhabiting different parts of the globe, *viz.*, the lungs of Dipnoi and the accessory air-breathing organs (in other words, the "lung mimics") of certain Indian teleostean fishes. Such facts are of fundamental importance, and certainly help us towards the understanding of the real course of Evolution.

(15) As a matter of fact it is often observed that even the best of the water-breathing fishes, *viz.*, Cyprinoids, most Siluroids and others, would madly run up to the surface of water in quest for a gulp of air, if the normal medium in which they live is rendered foul and turbid, or, in other words, if its oxygen-tension becomes considerably low, in as much the same way as what would happen if bubbles of CO_2 are continuously passed in an aquarium containing such fishes. Such a phenomenon is to be seen in a tank or a pond (nay, any small sheet of water containing fishes) which is rapidly drying up during the summer months (especially May and June), and such a state of affairs may be termed "*Notatmung*" (*i.e.*, breathing in a state of 'distress'), and indeed it is a very simple process to which the fish is forced to adapt itself under conditions of extreme deficiency of oxygen with a view to avert death due to asphyxia. It merely consists of aerating its mouth-cavity (*i.e.*, "mouth-ventilation") by constantly taking in of fresh bubbles of air and then giving them out after use at a fairly brisk rate. This mode of breathing (or as it is commonly called "gasping") performed by a large number of species of typically water-breathing fishes, *viz.*, Rohu (*Labeo rohita*), Mrigala (*Cirrhina mrigala*), Catla (*Catla buchanani*), many siluroids, etc., is a common sight in any such tank or pond in most parts of India during the hot summer under the mid-day sun, when the temperature of water naturally rises high and varies from 90°–100°F, or sometimes even more! Such a small beginning of taking in of atmospheric air directly would certainly stimulate and account for the development of accessory air-breathing organs in fishes in addition to their usual branchial mode of respiration.

(16) The course of evolution of the various types of air-breathing organs has been graphically illustrated towards the end of the paper: the opercular chamber of *Pseudapocrytes* undoubtedly represents *the simplest and the most primitive kind of a true air-breathing organ*, and forms the land-mark and the starting point from which the evolution of the *opercular "lung"* of other fishes must have taken place. This fact has already been foreshadowed during the course of the detailed study of the air-breathing organs of the fishes made by the author in 1927.

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Notes on the Kabuis of Manipur

By Jyotsna Kanta Bose, M.A., B.L.,
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THE Kabuis, it might be remembered, had recently witnessed a reaction against modern culture culminating in the revolt and capture of the semi-mystic, semi-political, 'Gadaulu' comparable to the 'Birsha' movement of the Mundas. Working amongst them twenty miles away from Imphal in 1931-32 we could gather many new data and check up some of the information given by Mr. T. C. Hodson. This group wedged in between the highly civilised Manipuris on the one hand and the more primitive Kukis on the other and linguistically more akin to a third group—the Nagas, is very interesting and a few striking features are given below.

The Kabuis generally inhabit the hills to the west and north-west of the Manipur valley. They are scattered over this tract sometimes in small and sometimes in large villages far away from each other. The large villages generally contain fifty to sixty houses and ten small villages of six or seven houses can also be found. Each house is inhabited by a single family, *i.e.*, father, mother and children.

By the very first glance at a Kabui a Mongolian strain can easily be detected by the typical Mongolic fold, the high cheek-bone and other characteristics. They are of moderate stature and tall men among them are very rare. The girls are generally ugly in appearance and have no idea of beauty and they shave their head till their marriage but now-a-days in some villages near Imphal girls dress their hair in the Manipuri pattern.

The Kabuis have got a large number of clans and these clans are divided into three divisions. These three divisions are exogamous. The kinship system of the Kabuis is classificatory and only eighteen words are used to address different relatives. They can marry their mother's brother's daughter but no other cousins are allowed to marry. Junior lavirate is very common among them but my informant told me that senior lavirate was also allowed by the society. Sororate is also in vogúe among them. 'Cheralung Luklakpa' (the second headman of the Noriya village) married both the daughters of 'Khunemlank' at a time; but this type of marriage of two sisters with one man at the same time is not very common.

The Kabui society is very elastic and its members are adopting new units into their own group. When taking genealogies a case occurred in which Singhir, a Garhwal from Nepal, was allowed to marry a Kabui girl and he was adopted in the royal clan of the Kabui society.

The Kabuis have the annual festival of 'Kumaichourel' in the month of January and at that time they offer sacrifices in honour of the dead persons and are engaged in dancing and music for some days.

The Kabuis near Imphal are much influenced by the Manipuris and day by day they are adopting the culture and the mode of living of the Manipuris and probably within few years one will hardly recognise a Kabui village from the Manipuri.

On the Possibility of Cultivation of Saffron *Crocus sativus* (Fam. Iridaceœ) in the Hyderabad State and its Importance.

By Inam-ul-Haq and M. Sayeeduddin, M.A., B.Sc., F.R.M.S.,
Professor of Botany, Osmania University.

IT is still maintained by the majority of people who know anything about cultivation of *Crocus sativus* that Kashmir alone can boast of cultivating it, and that no other soil and environment is suited for its growth. Our intention in writing this note is to bring to the notice of the learned readers that we have been able to perform a fairly successful experiment on the possibility of the cultivation of *C. sativus* in Hyderabad

It is believed by the Kashmirees, we are told, that this plant can be successfully cultivated only in certain areas and not in others; the prevailing belief is that saffron is the gift of a faqir (a saint we suppose) who lived near the village of Pampur. The land where he had ordered the seeds to be grown is the only area where this plant can thrive, and even the adjacent land does not yield saffron. Whether it is this belief that keeps back people from experimenting on different areas or not we are not able to say definitely. On the other hand it is said the soil was specially imported in Kashmir for growing this plant. As it is well known the famous saffron fields are situated in the vicinity of Pampur, on a plain fifty feet above the valley. All the four stations where *C. sativus* is grown are tree-less tablelands on an elevation of 5,200 feet above the sea-level. One of the authors (Mr. I. Haq) had been to Kashmir in the year 1929 to collect information about the cultivation of saffron. It was found that this plant is cultivated in stiff clay on raised parterres even without ploughing and irrigating it. The bulbs are planted out in June or July and the stigmata are collected in October or November.

About two years ago one of the authors managed to get the permission of the authorities to carry out his experiment on a small plot of ground in the Public Gardens, Hyderabad. Altogether thirty-two bulbs were planted out in a well-prepared soil under the poor shade of guava trees. In spite of the season being over and not having been properly taken care of every one of the bulbs brought forth a shoot which attained a height of about 13-14 inches. It being too hot in the year for the plants to thrive and flower they soon withered away. But the very fact that the bulbs produced quite healthy plants in spite of the conditions not supposed to be suited for their cultivation is very promising indeed. Given proper facilities for experimenting we believe that *C. sativus* could be cultivated in Hyderabad in enough quantity to meet the local demand. Like Dr. Downes we are of opinion that a special soil is not needed for the cultivation of *C. sativus*. It is possible that the climatic conditions prevailing here might affect the quality of saffron obtained. But the customary belief, that no soil other than that of Kashmir is suited for the growth of *C. sativus*, seems to us to be erroneous.

The uses which we have been able to gather from different sources are the following:—

Economic: In the majority of our dishes saffron is used as a colouring and flavouring agent. Dissolved in water it is used as an ink with which our priests and *amels* write charms or *tawiz*. *Medicinal:* Saffron is considered by our *hakeems* as hot and dry. It is said to reduce inflammations. It is a stimulant and stomachic. Considered a good remedy for enlargement of the liver and affections of the urinary bladder and kidneys, also in cholera. Administered in big doses it makes the patient unconscious. Mixed with other drugs it is used to help menstruation. It is strengthening to the heart and is a refrigerent for the brain. If soaked overnight in water and administered with honey it makes the patient suffering from urine trouble to pass the urine freely. Pounded with ghee it is used in diabetes.

Saffron oil is used as an external application in uterine sores. After extracting the oil from saffron the waste is also used in many diseases.

Considering the uses to which saffron is put it is worth while experimenting in different parts of India on its cultivation. Undoubtedly it is a very paying experiment.

We are indebted to Hakeem Yaseen Khan for giving us reliable information about some of the uses of saffron in native medicine mentioned above.

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Obituary.

Prof. G. C. Bourne, F.R.S.

WE regret to announce the death of Prof. Gilbert Charles Bourne, Emeritus Professor of Zoology and Comparative Anatomy in the University of Oxford, on March 8, at the age of 72.

After finishing his studies at Oxford and Freiburg he was elected a Fellow of New College and later its Tutor. He was then appointed as the Director of the new Marine Biological Laboratory at Plymouth, but after two years returned to his old University of Oxford, and in 1906 succeeded Prof. Weldon in the Linacre Chair of Zoology and Comparative Anatomy, which he occupied with distinction till his resignation in 1921.

Prof. Bourne besides publishing a large number of original papers on various subjects such as the Anatomy of a Millipede, the Structure and Growth of various Corals, the Anatomy of the Neritacea and other gastropods, an elaborate study of the crabs of the family Raninidae, was the author of one of the best elementary text-books on Comparative Anatomy entitled "An Introduction to the Study of the Comparative Anatomy of Animals" and contributed several parts to Lankaster's well-known "Treatise on Zoology".

Prof. Bourne was a brilliant teacher, of a friendly and generous disposition and was well known for his work as a rowing coach in the University of Oxford. He served in the Boer War, and during the World War was engaged in the training of recruits. Since 1919 he took a very active part in the work of the Advisory Committee on Fishery Research to the Development Commission of which he became the Chairman in 1931. He also did valuable work in connection with the Water Pollution Research Board of the Department of Scientific and Industrial Research.

He was elected a Fellow of the Royal Society in 1910, and was President of Section D (Zoology) of the British Association at Sheffield in the same year.

Research Notes.

Vivipary on the Sea-Shore.

A NEW explanation of the prevalence of the viviparous habit in the mangrove forests along the sea-shore, based on recent ecological work, is suggested by Mr. A. C. Joshi in the last number of the *Journal of Ecology* (Vol. XXI, No. 1, Feb. 1933). The author in his paper shows how the old hypotheses of Guppy, Schimper, Warming, Haberlandt, etc., are unacceptable in the light of present knowledge. His own explanation is as follows: "Recent experiments have shown that while many plants can grow in a saline soil, their seeds cannot germinate in such a soil—the salt solution hindering water absorption which is always essential for the germination of the seeds. The seeds of most inland halophytes germinate, most probably, only after good rains when the soil solution is very much diluted, but such a thing is not possible in the mangrove swamp and on the sea-shore. Rains make no difference there and the salt-content of the soil remains high and approximately uniform throughout the year. Vivipary or the germination of the seeds on the parent trees themselves is the only method by which the injurious action of the salts of the soil on the seeds, preventing them from germination could be avoided and it appears that this is the reason that plants with a viviparous habit have gradually become grouped on the sea-shore. The habit probably arose independently in the different plants in different localities as a variation from the normal due to environmental effects or some other unknown causes, as is fully proved by the occasional occurrence of vivipary in land plants in places remote from the sea. Of these species, the halophytic gradually shifted to the sea-shore where this habit proved really useful and, under the uniformly warm and saturated atmosphere of the tropical littoral lands, the original variations became a regular habit with the species. This habit is still very strong in the various mangrove species because it is really useful to them in tiding over one of the greatest obstacles in their environment."

Quadrics of Revolution through a Pair of Skew Lines.

IN a paper published in the *Jour. of the Indian Math. Soc.*, Vol. 17 by A. Narasinga Rao, a study was made of the metrical structure of the system of quadrics of revolution through a given conic, by obtaining an image of the system in line space, each quadric being represented by its "axis" of revolution. It was shown that the system was composite, the "axes" lying in one or other of two planes, the distinction corresponding to that between "prolate" and "oblate" spheroids.

In a sequel to the above, in the *Annamalai University Journal*, Vol. II, No. 1, the study is extended by A. Narasinga Rao and N. S. Srinivasachari to quadrics through two skew lines L_1, L_2 which may be taken to be $y=mx$, $z=c$; and $y=-mx$, $z=-c$ ($|m|<1$). The system has one degree of freedom and is again composite, breaking up pointwise into two quadratic sub-systems. The axes of revolution corresponding to them are the two reguli on the paraboloid $xy \sin\theta \cos\theta + cz = 0$, ($m = \tan\theta$). There are obviously no cones, but there are 5 members which are doubly degenerate (pairs of planes), of which 3 belong to each sub-system. In each sub-system there are pairs of congruent quadrics, while if L_1 and L_2 are perpendicular, we have sets of 4 congruent members 2 belonging to each sub-system. The locus of points for which the two quadrics of either system coalesce, is the same rational ruled quadric having L_1, L_2 for directrices and another double generator at infinity.

It is surprising that when L_1 and L_2 are conjugate imaginary lines, the quadric system contains neither ellipsoids nor hyperboloids of two sheets—quadrics which one associates with imaginary generators. The reason for this is that conjugate imaginary lines on such quadrics belong to opposite systems and are hence *not skew* unless L_1 and L_2 are conjugate isotropic lines ($y=\pm ix$, $z=\pm ic$) a case in which the correspondence itself becomes singular as the system contains a sphere whose "axis" is indeterminate.

The Biological Oxidation of Carbohydrate Solutions.

USING a percolating filter of special design, S. H. Jenkins (*Biochem. J.*, **27**, 245, 258, 1933) observed that the rate of decomposition of carbohydrates was not influenced by the nature of the nitrogenous compounds that were added, nearly the same amount of sucrose being oxidised per day, in all the cases. There was considerable loss of nitrogen from solutions having C:N ratios of 8·4:1 and 4·2:1 irrespective of the form in which nitrogen was supplied. Experiments with large-scale filters using beet-sugar factory effluents showed that the C:N ratio of the solutions was approximately 20:1 and that the loss of total nitrogen was over 20 per cent. When such filters were supplied with ammonium salts as the source of nitrogen neither nitrite nor nitrate could be detected in the effluent. When the source of nitrogen was mainly organic, no ammonia or any of its oxidation products could be detected. It would appear, therefore, that the liberation of nitrogen from ammonia or different organic compounds of nitrogen occurs entirely within the cells of micro-organisms concerned in the disposal.

The foregoing observations are of much practical significance with reference to the conservation of nitrogen in effluents of the type which the author worked with. The results would not, however, appear to be applicable to either domestic sewage or other forms of industrial wastes which are not so rich in carbohydrate matter.

How can Super-conductivity be Explained?

L. BRILLOUIN, in *Comptes Rendus*, **196**, 1088, 1933, has given an interesting discussion as to the manner in which super-conductivity can arise. The curve connecting the energy with the momentum of the electrons in crystals shows discontinuities for certain values of the momentum p, but in general the energy E is an increasing function of the momentum. It can, however, happen in the case of certain crystals with a face-centred cubic lattice—and super-conductivity has been observed only in such materials—that at two symmetrical points A, A′ the curve shows minima. In this case most of the electrons will be in states represented by the rising portions of the curve (which are symmetrical about the energy axis) B, B,′ but there will also be a small number in the states represented by A, A′. The current is given by $\frac{\delta E}{\delta P}$ (R. Peierls, *Eregebnisse der Exakten Naturwissenschaften*, p. 274, 1932). The total current is zero because of the symmetry of the curve giving $\frac{\delta E}{\delta P}$. But if by

some agency as for example, a sufficiently strong electric field, the numbers n_A and n_A' of electrons in the states A and A′ are made unequal, there will be a resultant current. This current will persist for a long time since the electrons cannot go from the state A to A′ or to B since they will then have to pass through a state of maximum energy and at extremely low temperatures the vibrations of the crystal lattice cannot impart the requisite energy to them. If the temperature is increased to the point when the lattice vibrations can give the necessary energy, the superconductivity is destroyed. The fact that the current in a state of superconductivity has a maximum value is explained by the fact that the difference $n_A - n_A'$ has an upper limit. If an electric or magnetic field having a magnitude above a certain limit be applied, the electrons will be made to pass from A to A′ or B and the symmetrical distribution being restored, the super-conductivity vanishes, as is actually observed. Since a thermal gradient cannot take the electrons from one state to another so as to produce the required inequality of n_A and n_A', the fact that there is no thermal super-conductivity finds a ready explanation.

Development and Probable Evolution of the Suctorial Disc in the Tadpoles of *Rana afghana* Gunther.

AN examination of a series of larval stages of *Rana afghana* has led Dr. S. L. Hora (*Trans. Roy. Soc. Edin.*, Vol. LVII, Part II, 1932-33, No. 15) to conclude that the evolution of the sucker in *Rana afghana* would be in the same line as that in Garra where a similar disc is found. The disc makes its appearance first in tadpoles of 9 mm. length where it is in the form of a light coloured area along the anterior lower border of the yolk mass. It gradually increases in development and becomes transformed into a fol of skin. The cement organs which are functional till now disappear after the disc is well formed though in some cases the two may co-exist when one is accessory to the other. The disc is essentially an organ developed as a consequence of the rapid streams in which the tadpoles live, necessitating a more powerful organ of attachment than the cement organ.

The Positive Electron.

IN *Physical Review*, **43**, 491, 1933, C. D. Anderson described a number of photographs of cosmic ray tracks taken with a vertical Wilson chamber designed by himself and R. A. Millikan, employing a magnetic field of 15,000 gauss. Some of the tracks could only be interpreted as being due to positive particles of the same mass as an electron. All other possibilities that suggested themselves had to be ruled out and the existence of a positive electron was thus rendered highly probable. P. M. S. Blackett and Occhialini (*Proc. Roy. Soc.*, **A. 139,** 699, 1933) were able to secure a large number of photographs of tracks of penetrating radiation by means of a new automatic device which makes the high speed particles associated with cosmic rays start the expansion required for the photographing of their own tracks, and after examining a large number of these photographs they have been led to the same conclusion as Anderson. The existence of positive electrons is predicted by Dirac's theory of the electron, but they are likely to combine with other particles to form nuclei or more probably combine with electrons to be converted into radiation so that they have not been observed in former experiments. According to Blackett and Occhialini the positive electrons might have been produced by the disintegration of neutrons: their occurrence in the experiments of Madame Irene Curie and F. Joliot would then be explicable. These investigators have re-examined their old photographs and taken fresh ones and report their interesting observations in *Comptes Rendus*, (**196,** 1105, 1933). With a magnetic field of 1100 gauss they found 2·83 positive electron tracks and 1·76 doubtful ones for every 10 negative electron tracks coming from the lead sheet used in their apparatus. At 610 gauss they found 4·5 positive electron tracks and 3·6 doubtful ones for every 10 negative electron tracks. When an aluminium plate was substituted for the lead plate, the positive electron tracks dwindled to 0·53 per 10 negative electron tracks, thus showing that the positive electrons came from the lead; when a lead screen of 2 cm. thickness was interposed between the plate and the source of neutrons, the positive electron tracks were reduced to half their original number. Since the neutrons are absorbed by the lead screen only to the extent of 12% while the accompanying γ-rays are very

much more absorbed, it follows that the positive electrons must have been disengaged from the lead plate by the γ-rays. This fact supports the hypothesis of Blackett and Occhialini that the emission of positive electrons is responsible for the anomalous absorption of highly penetrating γ-rays by heavy elements. Gapon (*Zs. f. Phys.*, **82**, 404, 1933), however, explains the anomaly by taking into account the neutrons within the nucleus.

Meiotic Phenomena in *Oenothera*.

S. HIDAYETULLAH (*P.R.S.*, No. B 780, Series B, Vol. 113, May 1, 1933) describes for the first time the meiotic phenomena in *Oenothera missouriensis*. In the leptotene the chromatin threads are irregularly running and the threads of the early leptotene gradually concentrate and bend round. The free ends of the folding threads are less in number than the early leptotene stage. The ends approach each other and form seven free bivalent ring pairs in diakinesis. The method of synapsis involved is acrosyndesis (telosynapsis). The nucleolus never attaches itself to the nuclear membrane in the early stages, but later moves and attaches itself to the nuclear membrane and finally disappears in late diakinesis. Reduction division is normal and regular and no non-disjunction of the chromosome pairs has been observed.

Leaf-curl in *Zinnia elegans*.

THE above investigation by R. N. Mathur, (*Indian J. Agri. Sci.*, **3**, 89, 1933) presents a unique instance of an insect carrier of a virus disease literally "walking into the net"! The small white-flies (*Bemisia gossypiperda*) which are the vectors of the disease passed the 20-mesh sieve employed by the author and transmitted the infection presumably from without. The disease closely resembles the leaf-curl of cotton: the vector of the infection is also closely allied to the carrier of the cotton disease. As distinct from Kirkpatrick's observations in the case of cotton, the Aleurodids concerned in the spread of the Zinnia disease had to be fed on diseased plant before they became infective.

The investigation was undertaken with a view to throwing some light on the mechanism of insect transmission of the spike-disease of sandal. The latter, however, has so far eluded all methods of insect transmission though readily communicated by artificial infection with the diseased tissue.

Permeability of Human Skin.

A. G. R. WHITEHOUSE and Hugh Ramage describe in an interesting article (*P.R.S.*, B.780, 1933) about the permeability of human skin to electrolytes. It is well known that the human skin, besides being a protective investment, acts also as an impermeable membrane for many foreign objects. The authors of the present paper point out that the skin was subjected to the action of a kation like Lithium. When the urine of the subject was tested after the experiment spectrographically no appreciable difference in the Lithium content was noticed. The anion Iodine in the form of KI solution was tried and estimated chemically; no difference in the iodine content was noticed after the experiment. This definitely proves that the human skin is impermeable to electrolytes in simple solutions. On the other hand, un-ionised iodine (in the form of an ointment) is rapidly absorbed by the skin.

The Quality Factor in Feeding Stuffs.

IN this paper, J. A. Murray (*J. Agric. Sci.*, **23**, 185, 1933) attempts to define the significance of the highly elusive factor, the quality, and to show its bearing on problems of animal nutrition. The nutritive value of a feeding stuff may be attributed to two factors, 'quantity' as indicated by the gross energy and 'quality' as represented by the coefficient of availability (D/T—0·35) where T is total and D digestible organic matter. The author applies his formula to the results of a number of feeding experiments and draws the conclusion that the nutritive value of the total organic matter depends almost entirely on its digestibility and except in the case of cakes, only to a negligible extent upon its chemical composition. Nutritive value is not proportional to digestibility but a linear function thereof. In substances of low digestibility, slight change in digestibility may cause manifold alteration in nutritive value.

It would be of much interest to extend the above observations to different types of animals, fodders raised on various kinds of soils and manures, and to feeding stuffs made up in diverse ways.

The Easter Meeting at Bangalore.

UNDER the joint auspices of the South Indian Sciences Association, Bangalore, the Society of Biological Chemists, India, and the Madras Branch of the Indian Chemical Society, a three-day meeting was held in Bangalore during the last Easter Week. The programme commenced on the 15th April with the Presidential Address of Dr. S. Subba Rao, B.A., M.B.C.M., L.R.C.P., etc., Senior Surgeon to the Government of Mysore, when he addressed the gathering on the place of the medical man among the scientists and pleaded for an application of the study of physics and chemistry to the problems of medicine and surgery. This was followed by the reading of several original papers on organic and physical chemistry under the presidency of Dr. P. C. Guha, D.Sc., Professor of Organic Chemistry, Indian Institute of Science, Bangalore. In the evening Sir Mirza M. Ismail, Dewan of Mysore, opened in the presence of a large distinguished gathering, the Sciences Exhibition organized by the Societies. In a felicitous speech Sir Mirza pleaded for a wider study of science in its application to humanity. The precincts of the Central College were *ên fete* and the Mysore Government Electrical Department had flood-lighted the central buildings of the College in honour of the occasion. This exhibition which demonstrated the fundamental principles of Physics, Chemistry, Botany, Zoology, Geology, Medicine and Pathology, Radio, Engineering, Biochemistry, Dairying, Nutrition, etc., was visited by more than 2,500 members of the public during the four days when it was kept open.

On the 16th there was a symposium on the "Ghee Problem in India" under the presidency of Dr. S. Subba Rao when the following papers were read and followed by an interesting discussion :*—

Dietetic value of ghee	Mr. N. C. Datta and Mr. B. N. Banerji.
Adulteration and Analysis	Mr. Y. V. Srikanteswaran.
Ghee substitutes, their manufacture and trade	Dr. R. Bhattacharjee.
Chemical aspect	Mr. P. Ramaswami Ayyar.

In the evening Rao Bahadur B. Viswanath, F.I.C., Government Agricultural Chemist, Coimbatore, delivered a public lecture on Plant and Animal when Sir C. V. Raman, Kt., F.R.S., N.L., presided. He said that the plant and the animal in their co-operative existence in nature bring about the marvellous round of events in which the inorganic is shaped into the organic which, passing through successive changes and displaying manifestations of life, pass again into the inorganic state only to resume the organic form. In this round of events he referred to the wonderful power of plants to build up their tissues from simple substances, and contrasted this with the helplessness of animals to utilize the same substances till they are made ready into a more suitable form by plant agency. He pointed out that although the structure and functions of the body parts of plants and animals have little in common, the recent contributions made to the biochemistry of plant and animal show that many of the typical functions of the cell are capable of being expressed in terms of simple chemical formulae or equations, leading ultimately to the simplification of phenomena and to the view that in its fundamentals the physiological mechanism of the two organisms is similar. From the epoch-making work of Willstatter and his collaborators similarity and relationship is visible between the vital centres of plants and animals, through their pigments chlorophyll and hæmoglobin from both of which ætioporphyrin can be obtained. Likewise instances were shown in which considerable similarity is revealed in the chemical changes underlying the metabolic and katabolic processes. While recognizing that analogies should not be stretched too far, the available evidence would justify consideration of the plant in terms of the animal in certain directions, and the lecturer showed how on the basis of such considerations it is possible to use the plant as an index or test organism in the solution of certain problems connected with animal life, such as nutritional, immunological and pharmacological studies.

On the 17th Dr. V. Subrahmanyan, D.Sc., F.I.C., Professor of Biochemistry, Indian Institute of Science, Bangalore, presided over the reading and discussion of original papers of biochemical interest. Dr. Gilbert J. Fowler, D.Sc., F.I.C., addressed on the Ern and Technocracy under the presidency of Prof. C. R. Narayan Rao, M.A., L.T.*

There was a number of delegates from Coimbatore and other places who contributed largely to the success of the Session.

* See page 400.

* Summary of this address has appeared in *Current Science*, 1, 11, 366, 1933.

The Ghee Problem in India.

THE Ghee Problem in India was the subject of a symposium held under the joint auspices of the South Indian Sciences Association, Bangalore, Society of Biological Indian Chemists (India) and the Madras Branch of the Indian Chemical Society, at Bangalore on the 16th April. The following papers were contributed :—

MR. B. N. BANERJI : "*The Metabolism of Fat.*"—From the physiological point of view, ghee is a mixture of true fat, *i.e.*, glycerides of fatty acids, lipoids like lecithin and cephalin containing nitrogen and phosphorus in combination, and the unsaponifiable sterols. In the animals two types of fats are distinguished—the tissue fat and the reserve fat. The former is uniform in composition while the latter depends on the diet. Fats from different parts of the body differ considerably in composition and consistency. Tissue fats are more unsaturated than reserve fats. The fats function an important rôle in metabolism. They yield the highest caloric energy and their ability to be stored up in large quantities makes them a convenient form of reserve food for the organism. They serve also as good insulators against temperature changes. Fats are an essential item of food and carriers of vitamins and other growth-promoting factors. Growth cannot be obtained on an entirely fat-free diet. Fat is digested in the intestines after emulsification by the pancreatic lipase. Most of the fatty acids are converted into soaps which are absorbed in the mucosa. They then pass into blood through the lymphatics. One to three hours after food the blood fat rises reaching its maximum in 6 to 7 hours after which it returns to normal. The oxidation and disposal of blood fat is obscure. The liver where desaturation takes place is the most important organ in fat metabolism. Apparently, all fats can be synthesised in the body, and proteins and carbohydrates can produce fat. But whether all the fatty acids can be synthesised is not known. Addition of linoleic acid to fat-free diet cures deficiency but not the addition of saturated acids. Linoleic acid therefore is not synthesised in the body. Fat excretion is fairly constant 5 to 10% being absorbed; there is no fat in urine, very little in sweat and the greater portion is excreted in the fæces. Age, sex, heredity, disturbance of endocrine glands, gonads and pituitary, alter the deposit of the fat pattern. However, there is no disturbance of fat metabolism in obesity. The factors that cause disturbance in blood fat are very meagrely understood. Blood is apparently a system for transportation, and many confusing notions are extant. The real metabolism of fat, the lipoids and sterols is not fully known, though their importance as an essential item in cell function and transportation is undeniable.

Lipoids are definite constituents of protoplasm. They act as carriers of fats in utilization by the cells. Lipoids are synthesised in the body from inorganic phosphorus. The sterols, cholesterol of animals and phytosterol of plants, are also important constituents of all protoplasm. Their importace in cell membrane functions and as carriers of vitamins are well known.

* * *

MR. N. C. DATTA : "*The Dietetic Value of Ghee.*"—The adulteration of milk products like ghee and butter is of recent origin in India. The introduction of vegetable ghee has made the problem of getting pure ghee rather difficult. Enormous quantities of vegetable ghee manufactured in India and also imported from other countries are used for adulteration purposes. Owing to lack of proper enforcement of the Foods and Drugs Adulteration Act, the adulterated ghee trade is flourishing very well. From the dietetic point of view, as a glyceride of fatty acids, in calorific value, vegetable ghee is equivalent to pure ghee but in contrast to other fats, pure ghee has certain peculiar properties, namely, low melting point and high emulsifying power. Many vegetable ghees are not so easily emulsified and melt at a temperature much higher than the body temperature, so that their use can be held objectionable on the contention that they will be less digestible than pure ghee. Ghee prepared by melting pure butter contains vitamin A and is found to be quite as good as pure butter, whereas the hydrogenated oils contain little or no accessory food factor so that vegetable ghee has not as good a nutritive value as pure ghee. Pure ghee and vegetable ghee sell almost at the same price in many parts of India so that the use of vegetable ghee does not hold good even on economical grounds.

In cities like Madras, Calcutta, Bombay, where milk and vegetables containing vitamin A are expensive, the poor and the middle class people are subsisting on the border of their vitamin A requirements. According to Sir McCarrison the diet of the people of Madras and Bengal are usually poor in vitamin A, so that the use of vegetable ghee will certainly affect the health of the people. Particular classes in certain cities, a few families everywhere and numerous individuals throughout the country suffer from a deficiency of vitamin A through the neglect of the use of milk, butter and ghee. The high rate of mortality, the ill-health of young mothers and incidence of diseases like tuberculosis clearly indicate the want of proper nutrition among the people of India. It is highly desirable from the physiological point of view that greater consumption of milk in the country should be encouraged.

India is essentially an agricultural country whose fertile soil and climatic conditions, particularly favourable for the growth of grass, make dairying a household industry well adapted for the country. Proper education among the farmers, and the use of plenty of green grass and sunshine enriching the milk with more of vitamins A and D, will offer the greatest promise to further development of Dairying in India.

* * *

MR. Y. V. SRIKANTESWARA IYER : "*Adulteration and Analysis of Ghee.*"—It is to be deplored that in India there are no satisfactory standards of supply of food materials. Most of the countries abroad have laws in accordance with which the sale of impure or adulterated foods is made a criminal offence and many are provided with public Analysts and other officers to enforce these laws and punish the offenders. The importance of legal control of such commonly used articles of food as milk, butter, ghee and various kinds of edible oils, etc., cannot be over-emphasized. So far, their manufacture and sale have not been legalized

in our country and it has afforded great opportunity for the growth of fraudulent trade.

The practice of adulterating food materials is comparatively of recent origin in India. There are two kinds of adulteration in practice. The scientific manner practised mostly in the Western countries and the non-scientific one that is generally prevalent in India. The non-scientific adulteration is easily detectable and therefore an efficient check, if exercised over the sale of the food materials, would completely efface this vicious practice. With the advent of the oil hardening industry and the establishment of factories for the purpose in some parts of India, there has been a great stimulus given to this kind of adulteration in oil trade which has been responsible in baffling the Analysts engaged in detecting these adulterations.

With respect to ghee, which is nothing but pure milk fat, the problem of adulteration is of great concern to our nation. The detection of adulteration of ghee has been the subject of many investigators. The common adulterants that one comes across in India are some of the local edible oils like groundnut, sesame, cotton seed and the cocoanut, which are capable of being easily detectable by ordinary physical tests alone. But with the introduction of the refining, bleaching, de-odouring, hardening and flavouring methods for oils, one finds these adulterants incorporated in such a scientific manner that it has complicated the problem of their detection to a very marked degree. In addition to these local adulterants, "lard" of different grades is well incorporated with butter fat or at times is itself flavoured with artificial butter aroma and sold under the name of pure butter fat. It is, however, well known that it is only pure milk fat that contains fatty acids of a soluble and volatile nature in considerable quantity that possess the property of easy emulsification and digestion in the human system. All other fats fail markedly in this respect. Perhaps it was on account of this feature of milk fat that the superiority of the use of butter was recognized in India. The various substitutes like oleomargarine, margarine, butterine, commonly used in the West and other similar products but containing lard, etc., while supplying the required heat units to the body do not do so with so much of ease and benefit as butter fat. Besides, instances have not been wanting to show that these products have had very baneful effects regarding the digestion on those that consumed them.

The analysis of oils and fats being the most difficult branch of analytical chemistry, the analyst is faced with innumerable difficulties in the absence of specific standards. The Western standards that are in vogue, in many instances, are wholly inapplicable to Indian products. Therefore, the necessity for the establishment of standards based on the results of a thorough investigation is keenly felt by many workers. Unless the Government and the well-established scientific institutions take up this piece of work, it is impossible to expect a better future for the supply of pure food materials on which only depends the health of our nation.

The methods commonly adopted for the analysis of ghee are mostly empirical. With a careful handling and strict adherence to the technique of the methods one could arrive with difficulty at the purity or otherwise of the sample in question. The chief factors that throw light on the purity or otherwise of the sample of ghee are refractive index at 40°C (42 to 44), saponification value (230 to 240), iodine value (30 to 35). R. M. value (20 to 30) and soluble fatty acids (3.5 to 4). The origin of the fat can fairly be established by performing the well-known "Phytosterol Acetate test" where the melting point of the substance determines whether it is one of animal or vegetable or a mixture. The usual value of the melting point obtained for the "Cholesterol" Acetate is 113·5°C to 114·5°C showing animal origin and for the Phytosterol Acetate, 127°C and 133°C showing vegetable origin. There are other colour tests, too, which are resorted to at times and which prove very helpful.

* * *

MR. P. RAMASWAMI AYYAR: "*The Chemical Aspect of the Ghee Problem in India.*"—From the Chemical standpoint "Ghee" is rather a vague term. It may be the milkfat of the cow or the buffalo, or, in rare cases, that of other animals like goat, sheep, camel, etc. These milkfats differ markedly in their properties; for example, at the ordinary temperature of 25°C, goat's ghee is a liquid, cow's ghee is semi-solid, and buffalo-ghee quite solid. These differences are due to the varying chemical compositions of these fats; thus, goat's ghee consists of a large proportion (above 10%) of the easily digested glycerides of the lower fatty acids, butyric, caproic, caprylic and capric and only a small proportion of the difficultly digested high-melting glycerides of palmitic, stearic and arachidic acids; whereas buffalo-ghee contains under 5% of the lower glycerides and over 50 per cent of the high-melting glycerides; while the composition of cow's ghee is intermediate in character. Most of the common edible fatty oils, like gingelly, groundnut, mustard and safflower oils do not contain any lower glycerides but are chiefly composed of the liquid glycerides, oleic and linolic acids with varying proportions of the high-melting glycerides of palmitic, stearic and arachidic acids; the only exception being cocoanut oil which contains up to 20 per cent of the lower glycerides. The value of cow's ghee as an article of diet of the Indian intelligentsia is a matter of experience; and in the absence of definite knowledge of the exact manner in which the various glycerides of cow's ghee are utilized by the human organism for its metabolic and energy requirements, it will be unsafe to put on the market, any synthetic fatty product resembling ghee, as ghee substitute, without chemically ensuring that it contains all the glycerides present in cow's ghee.

Most of the ghee-substitutes on the market are, unfortunately, made from hydrogenated groundnut oil or similar products. Actually hydrogenation destroys the liquid linolic glyceride converting it into that of a solid isoleic acid which is more difficultly digested and more prone to rancidity than oleic acid; further, much of the liquid oleic glyceride is converted into the high-melting stearic glyceride. producing, on the whole, a ghee-like fat but entirely lacking in lower glycerides and in linolic acid. These chemical deficiencies in ghee-substitutes may lead to serious deficiency diseases as has recently been demonstrated in the case of rats by the work of the Burrs during 1929 to 1932 (*J. Biol. Chem.*, Vol. 82, 86 and 97). Any ghee-substitute should, therefore, contain the essential components of cow's ghee along with

appreciable amounts of linolic glyceride. It is also advisable to ensure absence of all iso-oleic glycerides. Any oil-chemist can easily manage the production of such a ghee-substitute.

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DR. R. BHATTACHARJEE: "*Ghee Substitutes, their Manufacture and Trade.*"—The manufacture of artificial ghee has called for a large amount of research. Started as a war measure, margarine has taken a good place as butter substitute in Europe. In a poor country like India, where increase of population has led to encroachment on grazing lands, the price of a dairy product like ghee is very high and beyond the means of many. In towns it is very difficult to get unadulterated ghee, and most of the products are grossly adulterated with vegetable and animal fats that are positively harmful as food. It is always better to consume a standard, pure and refined substitute than a product adulterated with unknown and undesirable constituents mixed up by ignorant and unscrupulous traders. As such the production of a good substitute, artificially made, is an important problem. The manufacture of artificial ghee requires four distinct operations, namely, the preparation of the base, refining and de-odourising, hydrogenation and blending or developing the ghee odour. The preparation of the base necessitates a very careful mixing of the edible oils, like cocoanut, groundnut, sesame, etc., to make up the constituents as near to that of ghee as possible and great ingenuity is called for in the preparation of such a base. Well tried edible oils can be safely used in the preparation of the base. Oil chemists and technologists are busy in the making up of such a base. The process of refining and de-odourising has necessitated a high standard of technological operation. The product has to be made water white in colour absolutely odourless, and this requires the use of the best grade of oils. Again the acidity has to be brought down to as low a figure as 0·02% for hydrogenation. Naturally in hydrogenated fat we have one of the best refined fats possible. The process of hydrogenation gives us a product that is equal to the best samples of ghee in appearance and consistency. After hydrogenation the product has the same psychological value as any ghee on the consumer and his digestion. Finally, blending of the ghee odour requires the highest skill. Harmless odours are added, or the odour is developed biologically and then blended in the finished product with some suitable base. It cannot be said that the problem is solved because there are still a number of points to be tackled. There are four big factories in India that produce hydrogenated oils and besides a large amount of artificial ghee is imported from Holland which is the pioneer in this line. Time alone will determine the value of these substitutes on the health and future of the race. Digestibility and the question of vitamins A and D content have to be borne in mind. The researches of Windaus, Steenbock and Drummond have solved the question of vitamin D and it is hoped that the presence of vitamin A also will be ensured at an early date.

K. S. VARADACHAR.

Science News.

Chemical and X-ray Studies in Tertiary Coals.—DR. C. MAHADEVAN, Assistant Superintendent, Hyderabad Geological Survey, writes that chemical and X-ray investigations were carried out with tertiary coals of the same geological age and horizon ranging from peaty lignites to anthracites. Chemical analyses of the coals indicate that in coalification, the degradation of the cellulose of the vegetable matter is at first rapid and the lignin is more resistant, in conformity with the generally accepted views; but after a certain stage, the destruction of cellulose seems to proceed at a much slower pace while that of lignin is more rapid. The presence of small amounts of cellulose in coals (as represented by Makerwal and Mach specimens) is an interesting result in this study.

Lignins were isolated from the coals by digestion with alkali and purified. The X-ray pattern of all these lignins are practically identical and resemble the pattern for flax lignin. On a comparison of the X-ray patterns for the untreated flax and its lignin, it is seen that except for the observation of fibrous nature in the untreated flax the halos in the two cases show great similarity.

In the case of lignite from Palana, the end residual products after alkali autoclaving and acid treatment give X-ray patterns very similar to the 'gamma compound' pattern of coals.

The X-ray patterns obtained with the peaty lignites and lignitic coals in the untreated state consist of two halos, one intense and the other somewhat fainter, the corresponding spacings for the two groups being 3.59 Å.U. (intense), 2.43 Å.U. (faint) and 3.5 Å.U. (intense) and 2.23 Å.U. (faint) respectively. The anthracitic coals give quite a different pattern showing unmistakable indications of free carbon in fairly coarse state. The spacing for the tertiary coals, *viz.*, 3.5 Å.U., are distinctly different from the corresponding values, *viz.*, 3·39 Å.U., for permocarboniferous coals, in spite of apparent similarity of the composition as determined by "proximate analysis". These observations are discussed in relation to the geological history of the coal fields from where the specimens were obtained and in relation to the Bergius' theory of coal formation in nature.

It is seen that in conformity with the field observations, the X-ray patterns show progressive alteration to anthracitic stage with increasing pressure. The Palana lignites which have not been subjected to much pressure show larger spacings for the halo similar to a pattern for peat; the next set of coals,—Mach and Makerwal—have been subjected to moderate pressure and they correspond closely to the normal tertiary coals studied from other horizons. The anthracitic coals which are from a region of great tectonic activity give patterns characteristic of free carbon and mineral matter.

The distinct difference between the X-ray patterns of the tertiary and the upper palæozoic coals, especially the higher spacings for the former in spite of their similar "proximate composition"

points to a less compact structure of the fundamental coal substance in the tertiary specimens. The palæozoic coals seem to have reached the final stage of maturity. In normal palæozoic strata, anthracitic coals are absent. The existence, however, of anthracites in highly folded regions is attributed to the great pressure to which these regions had been subjected. The results of the X-ray study are in conformity with the above observations and support the Bergius' theory of coal and anthracite formation in nature. A detailed paper on the subject is under publication elsewhere.

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We have received a copy of the Annual Report of the Inter-University Board, India, for the year 1932–33 which details a record of the useful activities of the Board. The Board has continued its exertions to bring about a closer co-operation between the several Universities in the country by mutual recognition of the degrees conferred by each University and also by trying to maintain the same standards of efficiency throughout. We note with pleasure that, during the year under review, an attempt was made by the Board to co-ordinate the research work done at the different Universities which was met with a certain amount of success. We hope the Board will pursue this matter in greater detail and bring about a better understanding and closer contact among the individual research workers. The chapter on the introduction of Military Science as a subject of study in Indian Universities makes interesting reading. We regret to note that the Government of India have not come forward with that co-operation which might have been expected of them in this matter and as such the discussions have not led to any tangible result. We trust that the subject, which is promised to be discussed at the February meeting of the Board, will be taken up in earnest and a useful syllabus drawn up and that everything will be done to secure the full assistance of the Military authorities to successfully carry out the task.

The proposal of the Board to have a Central Advisory Board of Scientific Research was considered by a Committee appointed for that purpose with Sir C. V. Raman, F.R.S., N.L., as chairman who reported that general conditions were not propitious for the inauguration of such a scheme. We will discuss this subject at greater length in our editorial columns at an early date when we will have more to say on this matter. Meanwhile we are glad to note that the idea has been in the minds of several persons so that when a scheme is put forth it will receive wide and careful consideration.

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The Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England, have issued a Bibliography on the Breeding and Genetics of the Millets and Sorghums. The pamphlet contains a summary of the work done in Sorghums and Millets up to 1932 and contains 81 references listed in the alphabetical order of the authors' names. We are sure that all interested in this field of work will find this pamphlet, which can be had at a cost of 1*s*., a very useful reference.

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Mr. P. C. Biswas, M.Sc., Research Student, Anthropological Laboratory, Calcutta University, who has been studying the group Mal-Paharias and other allied sections of people, finds that the distinction between Mal-Paharias and Sauria Paharias is real and should not be minimised as has been done by Mr. S. Sirkar in his recent note on these people published in April number of *Current Science*. In the course of his investigations in the field, Mr. Biswas was unable to discover even a single case of intermarriage of Saurias. From the data that he has collected, he makes out thirteen clan names instead of eleven given by Mr. Sirkar and the names Ghuns and Pughor given by the latter writer are not supported by Mr. Biswas. He finds that the kinship terminology collected by him shows a strong Hindu influence and at least so far as present conditions are concerned, the descriptive nature of terminology is quite in accord with the absence of primitive forms of the dual organization such as is met with among the Aimol Kukis of Manipur.

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The Hon. Secretary, the Indian Chemical Society, 92, Upper Circular Road, Calcutta, announces that Prof. S. S. Bhatnagar has awarded a medal in commemoration of the Seventieth Birthday of Sir P. C. Ray, for the best single original contribution on any branches of Chemistry, published in the *Journal of the Indian Chemical Society* by an Indian Chemist of age not exceeding 30 years. The medal will be awarded every year.

* * *

The Sir Prafulla Chandra Ray Seventieth Birthday Commemoration Volume of the *Journal of the Indian Chemical Society* has just been published and contains articles on various branches of Chemistry, contributed by eminent Chemists of India and abroad. The price for Fellows is Rs. 3 and for non-Fellows Rs. 5. Copies can be had of the Secretary, Indian Chemical Society, Calcutta.

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The Indian Association for the Cultivation of Science.—We have pleasure in congratulating Prof. K. S. Krishnan on his election to the Secretaryship of the Association and on his appointment to Mahendra Lal Sircar Professorship of Physics. The creation of a permanent professorship at the Association is a notable event in the progress of Science in India and the appointment of Professor K. S. Krishnan who has been closely associated with Sir C. V. Raman in his work is a happy augury of the steady progress of work in the Institution.

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The Ninth Congress of the Far Eastern Association of Tropical Medicine will be held at Nanking, China, from 2nd to 8th October 1933. All licensed medical, dental and veterinary practitioners are eligible for membership. Members are privileged to attend and take part in the meetings and to present original papers. Further information relating to the Congress can be obtained from the Local Provincial Secretaries or from the Local Secretary, Government of India, Kasauli, Punjab, or the Hon. General Secretary, Far Eastern Association of Tropical Medicine, Batavia-Centrum, Java.

* * *

We acknowledge with thanks the receipt of the following:—

"Nature," Vol. 131, Nos. 3312 to 3314.

"The Chemical Age," Vol. 28, Nos. 720 to 723.

"The Journal of the Annamalai University," Vol. 2, No. 1, April 1933.

Minutes of the Convocation, Academic Council, Senate, Syndicate of the University of Madras.

"Canadian Journal of Research," Vol. 8, No. 3.

Bulletin of Applied Botany of Genetics and Plant Breeding of the Institute of Plant Industry, The Lennin Academy of Agri. Scs., Lenningrad, U. S. S. R., Second Series, Nos. 1 and 3.

"Scientific Indian," Vol. IX, No. 52, April 1933.

"Journal of the Indian Chemical Society," Vol. 9, No. 2, Feb. 1933.

"Transactions of the Royal Society of Edinburgh," Vol. LVII. Part II, No. 15, 1932–33—Development and Probable Evolution of the Suctional Disc in the tadpoles of *Rana afghana* Gunther—by Sunder Lal Hora.

Memoirs of the Indian Museum, Vol. XII, No. 2, pp. 263–330—Classification Bionomics and Evolution of Homalopteroid Fishes—by Sunder Lal Hora.

Goboid Fishes of Torrential Streams, by Sunder Lal Hora.

Buchanan's Ichthyological Manuscript entitled "Piscium Bengalæ Inferioris Delineationes" by Sunder Lal Hora.

Report on the Administration of the Government Museum and Public Gardens, Trivandrum, for the year 1107 M. E.

"The Quarterly Journal of the Geological, Mining and Metallurgical Society of India," Vol. IV, No. 4, Dec. 1932.

Communications from the Physical Laboratory of the University of Leiden, Nos. 205 to 216.

"Journal of Agricultural Research," Vol. 46, Nos. 4 and 5, Feb. and March 1933.

State College of Washington Agricultural Experiment Station, Pullman, Washington. Bulletin 277—Trends in the Apple Industry, by Chester C. Hampson.

Bulletin No. 278—The Production and Utilization of Corn grown under Irrigation in Washington, by H. P. Singleton.

"Journal of the Indian Chemical Society"—Sir Prafulla Chandra Ray Seventieth Birthday Commemoration Volume.

"Natural History," Vol. 33, No. 3, May-June.

The Nagpur Agricultural College Magazine, Vol. 7, No. 4.

"Berichte Der Deutschen Chemischen Gesselschaft" 66 Jahrg, No. 5, 1933.

Reviews.

ATOMS AND COSMOS, THE WORLD OF MODERN PHYSICS. By Hans Reichenbasch, Professor of Natural Philosophy, University of Berlin. English Translation by Edward S. Allen. (George Allen & Unwin, Limited, Museum Street, London.)

The revolutionary character of some of the fundamental concepts of Modern Physics has excited the curiosity of the ordinary educated man with no special knowledge of Physics. To allay this curiosity a large number of books have been published with the sole object of making these ideas intelligible to the non-specialist. Among such books a prominent place must be given to "Atoms and Cosmos" by Hans Reichenbasch. The book is based on the lectures which the author broadcast during the winter of 1929–30. After an introduction in which is stressed the point that it is possible to indicate the general trend of scientific progress to the layman without the usual machinery of mathematical investigation and formulæ, the author treats problems relating to Space, Time and the Special Theory of Relativity. In the next section comes for treatment, the Special Theory. We can safely say that the author has succeeded in his attempt to make these obstruse subjects intelligible to any one who takes pains to read carefully the words of the author, though such a reader may be unacquainted with Physics. Radiation and Matter, Radioactivity and related topics are next considered and receive a clear non-mathematical modern treatment. In Section 17 an attempt is made to give to the layman an idea of the wave character of matter which we owe to de Broglie and Schrödinger and of the work of Heisenberg and Dirac. It is doubtful, however, whether one who is not familiar with Modern Physics can really understand to any extent, by reading the book, the subjects treated in this section. If the reader finds any difficulty, the nature of the subject and not the author is to blame.

The vexed question of causality in relation to probability is taken up in Section 18. According to the author, Heisenberg's uncertainty principle sets up such barriers to advance calculation in atomic phenomena that even the Laplacian superman cannot pass. 'Nature is simply not completely determined.' As against this we may quote the words of Max Planck from his recent book *Where is Science Going*, 'And I have not been able to find the slightest reason to

give up the assumption of a strictly law-governed Universe'. One who carefully reads this recent book of Planck is impressed with the arguments he puts forward in support of his view that the law of causality must be taken to hold strictly in the entire world of physics.

In conclusion we strongly recommend this excellently written book to every one desirous of getting a general idea of Modern Physics in non-mathematical terms.

B. V.

* * *

AN INTRODUCTION TO THE CALCULUS. By G. Van Praagh. (Macmillan.)

A student of physics or chemistry often asks a mathematician to suggest a book on the calculus which satisfies his requirements and which is at the same time as concise and free from elaborate analytical theory as possible. For such students, this new book is likely to be useful. The mechanical processes of differentiation and integration are briefly but lucidly explained, and a number of applications to physics and chemistry are given, including a chapter on the determination of centre of gravity and moments of inertia. There are also short chapters on maxima and minima, partial differentiation, and differential equations, but the reviewer feels that these chapters ought to be slightly enlarged and should contain some examples by way of drill. The utility of the book will thereby be greatly increased, and will meet more satisfactorily the requirements of the physicist and the chemist. As it is, the book will be welcome to the general science student.

C. N. SRINIVASIENGAR.

* * *

THE MEANING OF ANIMAL COLOUR AND ADORNMENT. By Major R. W. G. Hingston, M.C., M.B. (Edwin Arnold & Co., London, 1933.)

Charles Darwin put forward the theory of sexual selection to give a scientific explanation of the fact of beauty in organic structures. It is a matter of common observation that the higher animals exercise discrimination in the selection of those individuals of the opposite for mating which, in their eyes, are superiorly endowed with colour ornamentation, offensive weapons or other capacities for emotional expression. It is usually inferred from these observed facts, that the animals which do not pair indiscriminately possess an æsthetic sense and because selection is influenced by artistic taste, the cause is sufficient to explain the phenomena of beauty among animals. The theory of sexual selection is entirely different from the theory of natural selection; the former deals with an explanation of the gorgeous, decorative and life embellishing structures which occur in one of the sexes in a more marked degree. The sexes differ not only in respect of their colour adornment, but also in respect of size, strength and the possession of weapons. It is an observable fact that those weapons, mostly confined to male members, are perfected at the time of maturity and are used in securing possession of the females by fighting with the male rivals. Darwin recognized in these mating contests the principle of the Law of Battle between the males of the same species and this principle forms part of the theory of sexual selection. It is true that in operation this principle of fight for possession is not sharply marked off from that involved in the struggle of animals for possession of territories, food and other natural advantages for continued and exclusive existence. In fact, the Law of Battle implied in the theory of sexual selection is as expressive of brute force and calls for the exercise of the very weapons which are involved in the explanation of the origin of the structures of utility. It is also to be recognized that the wealth of evidence accumulated in support of the sexual selection theory is not so overwhelming and convincing as that in support of the theory of natural selection. However, "the surprising uniformity in the laws regulating the differences between the sexes in so many and such widely separated classes is intelligible if we admit the action throughout all the higher divisions of the animal kingdom of one common cause, *viz.*, sexual selection." Wallace's views upon the subject and H. E. Howard's objections are well known.

Major Hingston's book has the rare merit of appealing at once to the specialist and to the general reader and represents a large wealth of information on animal habits in their natural environment. He has put forward an ingenious explanation of colour adornment, the songs, moults, offensive weapons and courtship, and the book is intended to be an exposition of the theory which he calls "Colour Conflict". The theory "asserts that every animal possesses two patterns of colour, one for concealment and one for war. Both patterns are important to it; the one in order to hide it from

enemies, the other in order to defeat its rivals. These two patterns are contending with each other and the colour of the animal is the result of that contention. It is partly concealing and partly threatening It cannot become more threatening without losing some of its concealing pattern. It cannot become more concealing without losing some of its threatening pattern. It is thus kept in a stable colour-state by the organic and inorganic influences that surround it. In the wild state it cannot deviate much from this stability without exposing itself to greater danger and in consequence being weeded out." This is the fullest implication of the new theory, which we may state at once is too defective to be a complete refutation of the theory of sexual selection or to replace the theory of natural selection.

As an illustration of his hypothesis, he takes the lion whose intimidating gestures include the spreading of his mane, the whisking of his tail above his back and drawing back his ears. These parts of the body bear the conspicuous black colour which is a menacing colour and the tawny background forms a concealing colour. In other words, the lion has a protective colour, superimposed on it there are threatening dark coloured patterns. From this circumstance Major Hingston argues that, movements of tail, the presence of beards or mane or ruffle and even non-hairy coloured patches of skin among mammals have the same significance. It is true that all cats move their tails when in anger, but they also whisk their tails sideways or tuck them up and erect their hair when they show affection; it is true that deer when alarmed put up their tail exposing the white under-surface, but they do just the same to express their joy at the sight of food and when engaged in courtship; it is true that the crimson callosities of baboons are wide and if, according to Major Hingston, they are used in intimidating their rivals, they should face back to back in their contests, but do they do so? Among the Ungulates, the tufted tail is erect above the back not only when two-hoofed animals fight, but also when they frisk about in exultation, when they butt against earth mounds in sheer excess of joy and when the calf sucks the udders of the cow. The author's ingenuity is remarkable when he attempts to explain the significance of hair in the axilla and pubis of man which he regards has the menacing value of the mane and tail of the lion. Primitive man not only fought but danced with uplifted arms and the hair in the axilla is exposed during nuptial embrace as well. The explanation of pubic hair as given by Major Hingston appears to us rather fantastic. We believe that its significance is to evoke and excite consciousness of sex. The presence of such hair in the two sexes does not lend support to the theory of colour conflict. If the greying of human hair is a sign of the loss of fighting qualities, it also signifies the cessation of man's reproductive powers. Major Hingston goes to the length of suggesting that the deeper pigment of the male human being is a threatening colour as contrasted with the lighter hue of the females at least among the East Indian races though not among the Europeans. If so the lighter European male members are less pugnaceous than the darker Indian races and are the women among the working classes lighter than their husbands and brothers? We have read the book from cover to cover and while we have derived much profit, we confess we have also derived much amusement. Those who are nurtured on the milk of Darwinism will hesitate to accept the conclusions of the book and the main reason is that Major Hingston does not recognize the fundamental fact that secondary sexual characters have an emotional, significance possessing both life-saving and life-embellishing values. Animal emotions including those of man are easily translatable one into the other and nature exercises economy in endowing the animals with structures and colour patterns for their expression. Thus the vocal organs of the crow, for instance, are adapted for expressing fear, defiance, mockery, anger, love, alarm and joy and it would be a narrow one-sided view to take if we postulate that the voice of all animals has the psychological significance of a call for battle. Major Hingston is not wrong in seeing threat in the tails, long hairs, songs, moults, and tusks and similar structures, including even the spurs and colour patterns of birds, but that is not the entire and comprehensive view to take for purposes of a generalization in the form of a theory. Nevertheless, we have pleasure in recording that the book is an excellent production which will fascinate the lay-reader by the wealth of interesting information which the author has marshalled in support of his theory. We believe that the specialist will be disposed to make marginal notes, and queries as he reads through the book. As a

book on natural history of animals, the book is entitled to high praise, though its contribution to the philosophy of biological science may not be regarded as of first rate importance.

* * *

HEARING IN MAN AND ANIMALS. By R. T. Beatty, M.A., B.E., D.Sc. (George Bell & Sons, Ltd., London, 1932.)

The purpose of this very interesting book, according to the author, is to provide in simple terms the general reader with a clear and connected account of the acoustic phenomena in animals including man and of the various sensory mechanisms by which they are rendered conscious of the range of sounds which are important for their welfare. The book is an exceedingly neat illustration of the fact that researches carried on in different departments of knowledge give little impression of their value unless they are correlated into a homogeneous concept in the interpretation of the vital phenomena of living organisms. In his studies of the structure of the ear and its functions, the author has drawn freely from the investigations of anatomists, physiologists, physicists, engineers and psychologists and the result is a compilation of interesting facts which give a coherent picture of the organ of hearing.

In the first two chapters are treated the structure and evolution of the different parts of the ear. The study of the development of the auditory ossicles of the mammalian middle ear and of the cochlea in birds and mammals is an important part of the study of comparative morphology and the account of their formation is in accord with the researches in embryology and palæontology. That certain bony elements of the lower jaw of reptiles shift from their position and enter into relation with the auditory organ of the mammals is a fact of profound evolutionary significance. The chapters on the resonance theory of hearing and sensations of hearing are physical and the mathematical portion is dealt with in a manner which can be understood even by those who have not the benefit of training in this branch of science. The account is complete, clear and correct. The physiological part of the function is treated in the subsequent chapters with equal clarity and precision. The section on noise has an importance to the general public and the administrators, which in our judgment should be read by them and understood in its manifold bearings.

We have read this little book with deep interest and the description of the structure and evolution of the organs of hearing in animals ranging from the insects to man provides a fascinating and profitable study. The great merit of the book is that it has dispensed with the horrible technical terms peculiar to the several sciences whose researches are made use of in the treatment of the subject, but without sacrificing scientific precision and logical deductions from the facts of researches. The book is a valuable contribution to the science of the physiology of sensory organs useful alike to specialists and to the general readers among whom we include legislators.

* * *

ECOLOGY OF THE FAUNA OF THE SALT RANGE, PUNJAB.

To the students of animal distribution and ecology the fauna of the Salt Range, Punjab, presents several features of great interest. For a number of years the animal life of this hot and dry tract, with peculiar conditions of the soil, was known from casual observations and collections made through the efforts of the earlier geologists Theobald and Waagen, in the course of their geological explorations. In 1922-23, however, the Zoological Survey of India made faunistic studies (*Rec. Ind. Mus.*, **25**, 365, 601 1923) of this region, and even then attention was mainly directed to the cold-blooded vertebrates and molluscs. It is a matter of great pleasure, therefore, that in the recent issue of the *Records of the Indian Museum* (pp. 87-119), Dr. H. S. Pruthi extends our knowledge of the aquatic animal life of this area by making "An Ecological Study of the Fauna of the Khewra Gorge and some other salt waters of the Salt Range, Punjab". He not only brings home to us the varied nature of the aquatic fauna, rich in insects, but also indicates, in a masterly way, the conditions of the peculiar environment to which the animals have become adjusted, evidently by a process of gradual colonization The physical and chemical factors of the environment are analysed, but unfortunately it is not indicated whether any structural modifications have resulted from the adaptation of animals to these very adverse conditions of existence. In concluding the article, Dr. Pruthi refers to the interesting question of the colonization of the sea by insects, and makes a tentative suggestion that, in all probability, the insufficiency of calcium is

ıe inhibiting factor, for he found the sect-fauna very rich and varied in the aters of the Khewra Gorge which had a rge amount of calcium in solution.

Even a cursory perusal of this interesting ·ticle shows the great range of adaptability › changes in salinity that is exhibited by ıe fauna, and also the plastic nature of the ıimals, which become moulded, presumbly . course of time, structurally (?) or at least hysiologically to highly adverse conditions : existence. What was the nature of the ıpulse behind this colonization of waters to 5 times as salty as that of the sea? robably it was the search of new feeding ·ounds, or may be that these highly saline aters provided shelter from enemies. It ill be of great interest to elucidate these ıteresting biological points.

S. L. H.

* * *

HAFFKINE'S PLAGUE VACCINE. By Lt.-ol. J. Taylor, *Indian Journal of Medical esearch Memoirs*, No. 27, 1933.

The above is a review of the extent of ıccess that attended the use of Haffkine's ague vaccine during the past thirty-four ›ars and of which thirty-six million doses ıve, so far, been issued in India as a easure of personal prophylaxis and for the duction of high mortality from plague.

The account of Haffkine's discovery reads ːe a romance. In 1895, Haffkine took up ork as the member of a Committee to vestigate the origin and nature of plague. ithin three months he immunised rabbits :ainst artificial inoculation of a virulent lture of *B. pestis* by previous subcutaneous jection of a sterilised broth culture of e same organism. Subsequent work was ›rely the extension of the fundamental inciple, but Haffkine had to spend a nsiderable part of his time in convincing ›dical authorities as well as the lay public the efficiency of his system of treatment!

In recent years considerable improvement the methods of obtaining growths of ulent cultures, testing for the potency of › vaccine and efficient bottling have been de. They relate mainly to (1) obtaining d material from passage animals by the ›ction of single colonies of culture tested ı reliable manner, (2) standardisation of chemical composition and the reaction ·he broth, (3) reduction in the period of ıbation to four weeks, and (4) introduction ı reliable method of final purity testing. › researches leading to the above together with the details of the present method of manufacture have been described by the author and make highly useful reading.

Analysis of the statistics relating to the use of the vaccine in India presents, however, several difficulties chiefly owing to the inadequacy of the records that are available. The results taken as a whole do, however, show in a convincing manner that among the inoculated population not only has the percentage of plague attacks been reduced, but that there has also been a marked decrease in mortality among those who have been inoculated.

The later chapters of the memoir relate to the vaccine and its properties. Experiments have been conducted with a number of animals susceptible to plague to study the properties of the toxin and the best ways of securing a serum with maximum immunising properties. The results have shown that the supernatant liquid is nearly as potent as the whole prophylactic. The vaccine prepared from a virulent culture is very much more potent than the one from a virulent strain. The toxicity of the vaccine is proportional to its potency, a fact which was first noted by Haffkine himself. Studies on the effect of storage have shown that the potency of the vaccine is not greatly effected by keeping even for several months. Researches on the standardisation of the products have shown that methods of plating and counting are generally ineffective. Haffkine's method for measuring the potency of the vaccine is useful but not quantitative. The more recent biological methods depending on the dose required to confer immunity in animals is highly reliable and has now been adopted as a measure of the potency. The methods of manufacture are now so standardised that the vaccine finally obtained is generally of a uniform composition so that further evaluation of potency is generally unnecessary. The use of a strain of high virulence, isolation and preservation of seed material under strictly uniform conditions, the adoption of a medium of fixed composition and reaction and incubation at regular temperature for a fixed period satisfy most of the requirements for obtaining the standard product so that the vaccine as prepared at present is not only uniform in composition and character but also highly potent in its action.

The memoir is a valuable contribution to an important subject and deserves careful study.

* * *

SIR PRAFULLA CHANDRA RAY SEVENTIETH BIRTHDAY COMMEMORATION VOLUME. Pp. v+362+portrait (Special number of the *Journal of the Indian Chemical Society*; Calcutta University Press). Fellows, Rs. 3; non-Fellows, Rs. 5.

It may be presumed that the purpose of a commemoration volume is to signalise the respect and esteem in which the subject of it is held among all his colleagues, who, to this end, are represented by a select body of contributors; and so few persons achieve the distinction proper to such veneration that it should not be difficult to ascertain whether this form of eulogy is the most agreeable to a majority of them. Probably to Sir P. C. Ray, who may be classified as a seagreen incorruptible, it is the most agreeable; but as one of his many admirers I would have greatly preferred an assemblage of impressions produced by the Father of Indian Chemistry in the minds of those numerous collaborators and others with whom, at various times and in various places, he has made ineffaceable contacts.

Stated otherwise, the defect of the present collection of memoirs, as a commemoration volume, is that you bid farewell to Sir P. C. Ray before attaining the first page, the only robust link with him being the delightfully characteristic portrait which adorns the opening. A much more attractive remembrance would have been his recently published autobiography, giving in his own inimitable manner the vivid and enlivening picture of an outstanding personality. As an appendix to this might have been offered the recollections of those who know and esteem him, thus bringing into light all the facets of his versatility, and saving from oblivion a variety of incidents and thumbnail sketches of ancillary figures; these would have reminded us of the sometimes forgotten fact that chemists are human beings.

Having written this in sorrow, not in anger, I have nothing but praise for the wealth of diverse and interesting material here presented. From the first item, appropriately introduced by the President of the Chemical Society, London, throughout until the last, by Dr. Franz Fischer of the Kaiser-Wilhelm Institut für Kohlenforschung, Mulheim-Ruhr, every contribution justifies its inclusion, and the prodigality of subjects recalls the bill-of-fare with which pre-War transatlantic liners were wont to dazzle their less fastidious passengers. A rough analysis of the 36 memoirs apportions their subjects among the following branches:—Physical (8), organic (7), colloidal (5), pyrochemical and biochemical (each 4), molecular (3), photochemical (2), thermodynamic, therapeutic and microchemical (each 1). The fact that only ten originate from countries other than India is no geographical measure of that admiration for the Master of Nitrites—a happy sobriquet due to Professor H. E. Armstrong—which is cherished by chemists. The general production is excellent, and gives evidence of more than ordinary care having been taken to preclude typographical blemish.

Thus the promoters of the volume, and the collaborators who gallantly responded to their invitation, deserve warm congratulation on the success of their enterprise, which is calculated to give the maximum pleasure in the proper quarter. Sir P. C. Ray amply merits this generous tribute. In his person, mind has triumphed over matter. Undeterred by frail physique, he has toiled unflaggingly and courageously in a climatic environment which would have speedily quenched a more indomitable spirit. Even yet the crusader has not sheathed his flashing sword, and the hope that he may long continue his constructive labours will be universal.

M. O. F.

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Title Index.

Errata.

Page 36, column 2, line 29, *for* 'Latin Square Method' *read* 'Checker-board Method'.

Page 38, column 1, line 47, *for* 'decrease' *read* 'increase'.

Page 102, column 1, lines 2 and 6, *for* '*Spiranthes australis* (Lindley)' *read* '*Zeuxine sulcata* (Lindley)'.

Page 272, column 1, figures, *read* magnification figs. 1 & 2. × Ca 230; fig. 3. × Ca 130.

Page 383, column 2, line 20, *for* '*Glossogobius alcocki*' *read* '*Glossogobius giuris* and *Ctenogobius alcocki*.'

Page 383, foot-note: *for* 'Gustacea' *read* 'Crustacea'.

Page 384, fig. 5 is printed upside down. As indicated in the description, the clouds are reflected in the water.

Page 384, column 1, line 33, *for* 'about Uttarbhag' *read* 'above Uttarbhag'.

Page 384, column 2, line 30, *for* 'fassigerous' *read* 'falsigerous'.

Page 385, column 1, line 24, *for* '*Python morulius*' *read* '*Python molurus*.'

Throughout the article contributed by Dr. Sunder Lal Hora (pp. 381-386) *for* '*Ophiocephalus*' *read* '*Ophicephalus*'; *for* '*Palæmon lamarreii*' *read* '*Palæmon lamarrei*'; and *for* '*Ambassia*' *read* '*Ambassis*.'

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